

MOSQUITO STUDIES (Diptera, Culicidae)

XIX. THE TREEHOLE ANOPHELES OF THE  
NEW WORLD<sup>1</sup>

By

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INTRODUCTION

The present paper is a review of the obligate treehole breeding *Anopheles* of the New World. It is essentially an expansion of my previous study of the treehole *Anopheles* of the United States (Zavortink, 1969).

The taxonomic procedure is that outlined for the project "Mosquitoes of Middle America" by Belkin, Schick et al (1965:10-11). Format, abbreviations and other details follow earlier papers in this series. I have not seen the types of *barberi*, *fausti*, or *xelajuensis*.

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### SYSTEMATICS

The American treehole breeding *Anopheles*, *barberi* Coquillett, 1903, *fausti* Vargas, 1943, *judithae* Zavortink, 1969, *xelajuensis* de Leon, 1938, and 2 species described here, *arboricolus* and *powderi*, belong to a single phylad. At least 2 of the numerous Old World species of container breeding *Anopheles*, *barianensis* James, 1911 and *plumbeus* Stephens, 1828, belong to this same line. This group of 8 species is differentiated morphologically and biologically, by its usual restriction to temperate or montane tropical regions, from the other phylads of container breeding anophelines.

As members of this group have some rather unusual features in the preimaginal stages, 3 generic group taxa have been proposed for included species: *Coelodiazesis* Dyar & Knab, 1906 founded on larval characteristics of *barberi*; *Cyclophorus* Eysell, 1912 on the immature stages of *plumbeus*; and *Russellia* Vargas, 1943 on larval peculiarities of *xelajuensis*. Despite its distinctiveness, this group of species is not currently recognized at the subgeneric level and is placed in *Anopheles* (*Anopheles*) (Stone, Knight and Starcke, 1959). This is because anophelines of several distinct phylads adapted to breeding in plant containers show convergence in some of the more conspicuous elements of the larval chaetotaxy, such as reduction of the frontal hairs of the head and elongation of lateral abdominal hair 6-IV-VI, and, as a consequence, students of the genus have been reluctant to use features of the immature stages to define or place them.

On the basis of morphology of the adult, male genitalia and larva, geographical distribution and habitat, the 6 species included here fall into at least 3 different primary groups: 1) *barberi* and *judithae*, 2) *fausti* and *arboricolus* and 3) *xelajuensis*. The affinities of the poorly known *powderi* are uncertain. The geminate species *barberi* and *judithae* differ most conspicuously from the others in the following features: as adults by 1) interocular scales absent or short, 2) erect head scales not brilliant white mesally and very dark laterally, 3) mesonotum shortened and arched, 4) mesonotum without broad hoary median longitudinal stripe, 5) acrostichal scaling absent or reduced, 6) coxae more or less same color as adjacent portions of pleuron, 7) femora and tibiae entirely dark scaled and 8) wing fringe dark; in the male genitalia by the scaleless sidepieces; as larvae by hair 3-C mesad of 4-C. These species are widespread in various types of forest in North America. The group consisting of *fausti* and *arboricolus* differs as follows: in the adult stage by 1) light patches on palpus, 2) hindfemur but not hindtibia conspicuously marked with white and 3) wing with a single light fringe spot at ends of branches of vein R; in the male genitalia by 1) sparsely scaled sidepiece, 2) clumped spicules on sidepiece and

3) outermost 2 setae on ventral lobe of claspette subequally developed; in the larva by plumose hairs 11-C, 9-III-VI, 4-IV,V and 10-VII. Both species have restricted distributions, *fausti* in the tropical rainforest at the base of the Sierra Madre Oriental in central Mexico and *arboricolus* in the humid montane forest of western Panama. *An. xelajuensis* is distinguished as follows: first, by its large size in all stages, then, in the adult by 1) hindfemur and hindtibia both conspicuously marked with white, 2) light patch over apex of costa and vein  $R_1$ , 3) wing with 4 light fringe spots and 4) wing veins with dark spots caused by accumulation of scales; in the male genitalia by 1) long sidepiece and 2) numerous scales on sidepiece; in the larva by 1) hair 3-C thick and blunt, 2) absence of palmate hairs and 3) presence of many stellate hairs. It is apparently limited to areas of wet montane forest in southern Mexico and Guatemala. *An. powderi*, unknown in the male and larva, is large in size, has a single light fringe spot extending from  $R_1$  to  $M_{1+2}$  and has only the hindfemur conspicuously marked with white. It has been collected in the montane cloud forest of southern Costa Rica. The differences between these groups are summarized in Table 1. I am not recognizing these groups even informally because the knowledge of the Central American species is still very fragmentary and I have not studied the Old World species in detail.

Very little is known about the bionomics of species in this group. The immature stages are restricted to treeholes or those artificial containers which approach them in water composition. Larval development is unusually long. Larvae of *barberi* are predacious and those of other species readily eat insect fragments. Adults of both sexes are occasionally found resting in buildings, culverts and hollow trees and females of *barberi* and *xelajuensis* bite man. Stratman-Thomas and Baker (1936:182-183) infected *barberi* with *Plasmodium vivax* and demonstrated transmission of the malaria to another person. However, this species has not been incriminated as a natural vector. American treehole *Anopheles* extend from the northern United States (South Dakota to New York) to northern Panama (Chiriqui). All six known species are apparently allopatric.

Since *An. eiseni* Coquillett, 1902, a Neotropical species unrelated to those treated here, is occasionally found breeding in treeholes, it has been included in the keys.

## TAXONOMIC TREATMENT

### DESCRIPTION OF GROUP

**FEMALES.** *Head*: Adorned with erect scales only; labium entirely dark scaled; palpus long, about 0.85-1.10 length of proboscis; torus and first flagellar segment with a few small dark scales. *Thorax*: Mesonotal bristles quite long; mesonotal scales absent or restricted to a median tuft on anterior promontory or an acrostichal line; *apn*, *sp*, *pra*, *ppl*, *stp* and upper *mep* bristles or hairs present, those on *stp* in a more or less continuous vertical row; pleuron without scales. *Legs*: Coxae without scales; femora and tibiae never mottled, light scales completely absent or restricted to small patches or rings at apex of segments; tarsi entirely dark scaled; tarsal segment 5 of all legs much shorter than segment 4. *Wing*: Never with conspicuous pattern of light patches or speckles, light scales completely absent or restricted to fringe and apex of anterior veins. *Haltere*: Knob dark scaled. *Abdomen*: Scales completely absent. *Buccopharyngeal Armature*: Not studied.

**MALES.** Similar to females except for sexual differences. *Head*: Flagellum strongly plumose.

MALE GENITALIA. *Sidepiece*: A single strongly developed internal spine and 2 strongly developed parbasal spines present; lateral parbasal spine longer than mesal; scales absent, few or numerous. *Claspette*: Dorsal lobe sclerotized, bearing 3 (rarely 4) overlapping spatulate apically curved setae; ventral lobe conical, spiculate mesally, bearing 3 long and 1 short setae. *Clasper*: Usually longer than sidepiece. *Phallosome*: Aedeagus without leaflets, apex rounded.

PUPAE. Setae generally weakly to moderately developed, relatively short, fine, few branched and lightly pigmented. *Cephalothorax*: Lightly to moderately pigmented, with middorsal area, region caudad of trumpet and upper portion of wing-case slightly darker; hairs 6,7-C relatively close together, separated by a distance less than 0.5 that between 4,5-C; hair 7-C distinctly smaller than 6-C. *Trumpet*: Largely light to dark amber or brown in color, base lighter; rather "culicine" in shape, not strongly flared or deeply divided, the pinna relatively small. *Abdomen*: Generally lightly to moderately pigmented, with anterior and/or lateral portions of most segments slightly darker; hair 9-I small, subequal to or shorter than 3-I, usually single (single, double); 2-II relatively short, single; 1-III-VII and 5-III,IV frequently single, never with more than 5 fine branches, less than 0.4 length of corresponding segment; 5-V-VII similar to 5-III,IV or thickened and then sometimes elongate; 9-IV-VIII spinelike, long, slender, pointed, becoming progressively longer on posterior segments, usually simple but sometimes with a few coarse branches near tip on segments VII and VIII. *Terminal Segments*: Hair 1-IX not irregular as in most other Anophelini, but instead a simple single or double seta. *Paddle*: Lightly to moderately pigmented; more or less elliptical to oboval in shape, never more than slightly emarginate; outer part wider than inner; external buttress long; outer margin, to beyond end of external buttress, serrate, with teeth becoming more prominent and numerous apically; remainder of margin smooth or weakly serrate, never with long spicules; hair 1-P thickened, spinelike.

FOURTH INSTAR LARVAE. *Head*: Setae generally poorly developed; head longer and collar narrower than in most Anophelini; maxillary sutures very short; moderately to deeply pigmented, tan to brown, with subantennal area and collar darker and ocular area lighter, never with pattern of contrasting colors; hairs 3-10-C relatively short, fine, usually single (1-4b or f), never large and plumose; 11-C weakly developed, short, usually not extending beyond level of hair 1-A. *Antenna*: Short, frequently smooth; uniformly moderately to deeply pigmented, tan to brown, or becoming lighter apically; hair 1-A short, fine, single, arising on dorsolateral surface near middle of shaft. *Thorax*: Integument without conspicuous branched spicules; hair 0-P apparently not developed; 11-P,M,T subequal, very small; 9-M,T not short and stout, at least as long as hair 10 of corresponding segment; 3-T never palmate. *Abdomen*: Hair 1-I not palmate, very small, shorter than hair 2 (except in *xelajuensis*); 1-II-VII or 1-III-VII (*xelajuensis* excepted) palmate, the leaflets well developed, broad, usually serrate apically; 6-I-VI long, plumose, nearly equally developed on all segments or 6-III-VI or 6-IV-VI less strongly developed; 4-IV,V (except in *xelajuensis*) elongate, longest hair on dorsal surface of respective segment; 5-IV-VII (except in *xelajuensis*) elongate, with relatively few weak and short lateral branches. *Spiracular Lobe*: Pecten with most teeth, except apically, long, never with regular sequence of long and short teeth; hair 1-S usually single (1-3b) or with fine apical branches, never with numerous long branches from base.

## KEYS TO SPECIES

## ADULTS

1. Hindtibia, but not hindfemur, with a conspicuous broad apical white ring; vein R sometimes with light patches at level of ends of veins 1A and Rs (see Systematics) . . . . . *eiseni*  
Hindtibia without a conspicuous broad apical white ring, apex dark or with a conspicuous white patch; hindfemur sometimes with a conspicuous apical white ring; vein R without light patches at level of ends of veins 1A and Rs . . . . . 2
- 2(1). Mesonotum without a broad hoary median longitudinal stripe and with scales absent or restricted to a tuft in center of anterior promontory; hindfemur entirely dark scaled; wing fringe entirely dark scaled . . . . . 3  
Mesonotum with a broad hoary median longitudinal stripe and a long acrostichal scale line; hindfemur with apical white ring; wing fringe with apical light spot . . . . . 4
- 3(2). Bristles on *ppl* 6-11; anterior forecoxal bristles 19-32; anterior acrostichal bristles dark and usually not accompanied by scales; light erect head scales dingy yellowish (fig. 2). . . . . 1. *barberi*  
Bristles on *ppl* 2-5; anterior forecoxal bristles 6-18; anterior acrostichal bristles amber and accompanied by 5-20 whitish scales; light erect head scales pale white. . . . . 2. *judithae*
- 4(2). Apex of costa and vein R<sub>1</sub> light scaled; small light fringe spots present at ends of veins M<sub>1+2</sub>, M<sub>3+4</sub> and Cu<sub>1</sub>; dark wing spots present (fig. 12). . . . . 5. *xelajuensis*  
Apex of costa and vein R<sub>1</sub> dark scaled; without fringe spots at ends of veins M<sub>1+2</sub>, M<sub>3+4</sub> and Cu<sub>1</sub>; wing without dark spots . . . . . 5
- 5(4). Palpus with light scales at joints and apex; wing moderately scaled; scales in middle of vein 1A clasping vein or slightly spreading (fig. 12) . . . . . 3. *fausti*; 4. *arboricolus*  
Palpus entirely dark scaled; wing profusely scaled; scales in middle of vein 1A wide spreading (fig. 11) . . . . . 6. *powderi*

## MALE GENITALIA

(6. *powderi* unknown)

1. Aedeagus with 1 pair of conspicuous serrate leaflets; dorsal claspette lobe with 2 terete setae (see Systematics) . . . . . *eiseni*  
Aedeagus without leaflets; dorsal claspette lobe with 3 flattened setae . . . . . 2
- 2(1). Sidepiece long, scales numerous (fig. 9) . . . . . 5. *xelajuensis*  
Sidepiece shorter, scales absent or few . . . . . 3
- 3(2). Lateral 2 setae of ventral lobe of claspette subequal in development; spicules of sidepiece grouped into large clumps; sidepiece usually with at least 1 or

- 2 scales (fig. 12) . . . . . 3. *fausti*; 4. *arboricolus*  
 Lateral seta of ventral lobe of claspette not as strongly developed as adjacent  
 seta; spicules of sidepiece arranged singly, in rows, or in small clumps; side-  
 piece usually without scales . . . . . 4
- 4(3). Parabasal spines much more strongly developed than internal spine; lateral  
 parabasal spine flattened preapically; sidepiece usually more or less ellip-  
 tical in shape (fig. 3) . . . . . 1. *barberi*  
 Parabasal spines only slightly stronger than internal spine; lateral parabasal  
 spine not flattened preapically; sidepiece usually more or less cylindrical  
 or short conical in shape (fig. 5) . . . . . 2. *judithae*

## PUPAE

(3. *fausti* and 4. *arboricolus* unknown)

1. Trumpet deeply divided; paddle margin with fringe of long, fine spicules (see  
 Systematics). . . . . *eiseni*  
 Trumpet not deeply divided; paddle margin without fringe . . . . . 2
- 2(1). Hair 7-VII single, longer than 9-VIII; hair 0-VII enlarged, multiple; 5-V more  
 strongly developed than 1-V (fig. 9). . . . . 5. *xelajuensis*  
 Hair 7-VII 2,3b (1-4), shorter than 9-VIII; hair 0-VII small, single (single,  
 double); 5-V usually less strongly developed than 1-V . . . . . 3
- 3(2). Large species, width of segment VIII greater than 1.00 mm (fig. 11) . . . .  
 . . . . . 6. *powderi*  
 Small species, width of segment VIII less than 0.85 mm . . . . . 4
- 4(3). Hair 9-III-VIII darkly pigmented; 9-III more similar in size to 9-IV than 9-II;  
 hair 5-VI, VII thickened, single (fig. 3) . . . . . 1. *barberi*  
 Hair 9-III-VIII concolorous with integument; 9-III intermediate in size be-  
 tween 9-II and 9-IV; hair 5-VI and usually 5-VII fine, 2,3b (fig. 5) . . . .  
 . . . . . 2. *judithae*

## FOURTH INSTAR LARVAE

(6. *powderi* unknown)

1. Hairs 4-6-C long, plumose; 3-T palmate (see Systematics) . . . . . *eiseni*  
 Hairs 4-6-C shorter, never plumose; 3-T not palmate . . . . . 2
- 2(1). Hair 1-III-VII stellate; 9-III-VI very strongly developed, stellate, long, 6,7b (5-  
 9); hair 3-C thickened, apex usually blunt (fig. 10) . . . . . 5. *xelajuensis*  
 Hair 1-III-VII palmate; 9-III-VI moderately developed, not stellate, elongate  
 and plumose or shorter and 2-4b (1-5); hair 3-C fine, apex attenuate . . 3
- 3(2). Hair 3-C mesad of 4-C; hair 9-III-VI not elongate or plumose; 7-VII much  
 more strongly developed than 6-VII . . . . . 4  
 Hair 3-C laterad of 4-C; hair 9-III-VI elongate, plumose; 7-VII not as strongly  
 developed as 6-VII . . . . . 5

- 4(3). Inner clypeals (2-C) widely spaced, separated by a distance greater than 2.0 that between inner and outer clypeals (3-C); hair 13-II-V, VII usually 3b (3-5); integument on underside of prothorax and abdominal segments I-VIII spiculose (fig. 4) . . . . . **1. barberi**  
 Inner clypeals (2-C) closely approximated, separated by a distance less than that between inner and outer clypeals (3-C); hair 13-II-V, VII usually single (1-3b); integument of thorax and abdomen not spiculose (fig. 6) . . . . . **2. judithae**
- 5(3). Hair 9-I, II elongate, plumose; 13-II-V with many fine inconspicuous branches beyond middle; antennal shaft with conspicuous spicules (fig. 7) . . . . . **3. fausti**  
 Hair 9-I, II not elongate or plumose; 13-II-V with 3, 4 (2-6) conspicuous branches from base; antennal shaft without conspicuous spicules (fig. 8) . . . . . **4. arboricolus**

### 1. *Anopheles (Anopheles) barberi* Coquillett

Figs. 1-4

1903. *Anopheles barberi* Coquillett, 1903:310. TYPE: *Holotype* ♀, Plummer's Island, Maryland, United States, 17 Aug 1903, H.S. Barber [USNM, 6959].

*Anopheles (Anopheles) barberi* of Edwards (1921:272); Dyar (1928:454); Matheson (1944:114-115); Darsie (1949:524-525); Penn (1949:65-66); Carpenter and La Casse (1955:32-34, in part); Stone, Knight and Starcke (1959:15, in part); Carpenter (1968:72, in part); Zavortink (1969:31-33).

*Anopheles barberi* of Dyar (1904:243-244); Dyar and Knab (1907:49); Stratman-Thomas and Baker (1936:182-183); Vargas (1942a:172, 173, 174; 1942b:329-331); Russel, Rozeboom and Stone (1943:21, 31, in part); Jenkins and Carpenter (1946:35-36, in part); Petersen, Chapman and Willis (1969:134-135).

*Anopheles (Coelodiazesis) barberi* of Dyar (1918:142); Vargas (1943:64, 65, 66, 67, in part); Vargas and Martinez (1956:111-113, 140, in part); Vargas (1959:373).

*Coelodiazesis barberi* of Dyar and Knab (1906:177); Howard, Dyar and Knab (1917:1036-1038).

**FEMALE** (fig. 2). Wing: 3.49 mm. Proboscis: 1.73 mm. Forefemur: 2.10 mm. Abdomen: about 2.2 mm. A small light-colored species. *Head*: Integument light to dark brown; interocular bristles dark or amber; erect scales long, usually dingy yellowish mesally, dark or dingy yellowish laterally; interocular scales absent or very few, short and dingy yellowish; palpus entirely dark scaled, the proximal scales appressed. *Thorax*: Mesonotum shortened and arched; mesonotal integument very light to dark brown, largely shining, without a broad hoary median longitudinal stripe; pleural integument lighter than that of mesonotum or becoming lighter ventrally; mesonotal bristles numerous, strongly developed, very long and conspicuous, dark in color; mesonotum without scales or sometimes center of anterior promontory with 1-4 narrow dark scales; *ppl* bristles 6-11. *Legs*: Coxae more or less same color as adjacent portions of pleuron; anterior forecoxal bristles 19-32; femora, tibiae and tarsi entirely dark scaled. *Wing*: Veins and fringe entirely dark scaled, scales on veins uniformly distributed and not grouped into dark spots; moderately scaled; scales in central portion of vein 1A clasping vein or slightly spreading. *Abdomen*:

Integument of tergites light to dark brown, usually somewhat dappled, sternites lighter.

MALE (fig. 2). As for female except for sexual differences.

MALE GENITALIA (fig. 3). *Sidepiece*: More or less elliptical in shape, short; spicules arranged singly, in rows, or in small clumps; scales usually absent; parabaasal spines much more strongly developed than internal spine; lateral parabaasal spine flattened preapically, apex sharply attenuate and recurved or sinuous; internal spine not more strongly developed than large setae of sidepiece, apex usually sinuous. *Claspette*: Most lateral seta of ventral lobe distinctly shorter and/or finer than seta next mesad. *Clasper*: Without spicules near base.

PUPA (fig. 3). Abdomen: 3.04 mm. Trumpet: 0.37 mm. Paddle: 0.88 mm. Width of segment VIII: 0.73 mm. *Cephalothorax*: Moderately pigmented with darker areas more extensive than in *judithae*; hairs 1,3-C subequal in length. *Trumpet*: Dark amber to brown in color. *Abdomen*: Moderately pigmented, darker areas more extensive than in *judithae*; hairs 6,7-I subequal in length; 1-II,III usually single or double; 5-III-V short, fine, usually single; 5-VI,VII thickened and single, usually shorter than to subequal in length to hair 9 of corresponding segment; 9-III-VIII darkly pigmented, strongly contrasting with abdominal integument; 9-III approaching 9-IV in both diameter and length; 0-VII very small, usually single (single, double); 7-VII usually double (single, double), shorter than 9-VIII. *Paddle*: Moderately pigmented, midrib darker.

FOURTH INSTAR LARVA (fig. 4). Head: 0.65 mm. Anal Saddle: 0.27 mm. *Head*: Inner clypeals (2-C) widely spaced, usually separated by a distance greater than 2.0 that between inner and outer clypeals, single and simple; outer clypeals (3-C) far mesad of 4-C, fine, single; 11-C not plumose, single or 2,3b. *Antenna*: Spicules absent or inconspicuous; hair 4-A simple and single. *Thorax*: Integument, especially on underside of prothorax, spiculate; hair 2-P short, plumose, with numerous lateral branches; 8-P long, shaft not notably thickened, lateral branches short and moderately numerous; 8-M short, all lateral branches long; 8-T a normal plumose hair; 9-P,M,T spiculate. *Abdomen*: Integument on underside of segments 1-VIII spiculate; hair 1-I very short, single, 1-II simple to palmate, 1-III-VII palmate; 6-I-VI similar in development and length; 9-I-VI moderately developed, with branches arising near base, never stellate or plumose; 13-II-V,VII moderately developed, usually 3b (3-5); hair 4-IV,V simple, single; 5-VII moderately long with 2,3b (1-3) arising near base; 7-VII moderately long, usually single or double (1-3b); hair 10-VII not plumose but single or 2,3b or 2,3f. *Segment VIII*: Hairs 3,5 usually with 3,4b (1-5) arising near base. *Anal Segment*: Spicules of saddle moderately conspicuous, located along ventral and caudal margins; hair 1 simple, usually single.

SYSTEMATICS. Although *barberi* and *judithae* are a pair of closely related allopatric species, they are easily separated in all stages on the basis of the characters given in the keys.

Examination of more specimens since the publication of my earlier paper (Zavorzink, 1969) has indicated that some changes need to be made in the description of *barberi* presented there. In the male genitalia the ratio of the distance from the parabaasal spines to the internal spine to the distance from the latter to the apex of the sidepiece should be broadened from 0.8-1.0 to 0.6-1.6 and the entire proctiger section should be deleted. In the pupa hair 5-VI,VII is sometimes longer than previously indicated and is then subequal in length to hair 9 of the corresponding segment. In the larva hair 1-II is frequently palmate and 7-VII is often double or triple.

The following extremes in variation of chaetotaxy of the pupa have been seen:



hair 5-VI is fine, as in *judithae*, on a single specimen from Ithaca, New York; hair 5-V is thickened, as in *xelajuensis*, on one side of the only specimen available for study from the Baltimore, Maryland, area; hair 9-VI,VII is shortened in some specimens from Ithaca and hair 5 of the corresponding segment is then longer than it.

*An. barberi* is apparently the most modern species of the group. It is widespread, occurring throughout the eastern half of the United States, and the vestiture of the adult is the most derived of any New World treehole *Anopheles*.

**BIONOMICS.** *An. barberi* is found at elevations of less than 1200 meters. The immature stages are found in rot holes in trees and stumps and in artificial containers, particularly those made of wood or containing leaves and twigs. Since long periods of unfavorable weather, at least in the northern portion of its range, are passed in the larval stage, the species is usually recovered from sites which contain water more or less continuously. More than a dozen larvae are seldom collected together; this is apparently due to their predacious nature. Adults are occasionally found resting in buildings and culverts and under bridges. Both sexes are attracted to lights and females are attracted to humans.

**DISTRIBUTION** (fig. 1). *An. barberi* is the most widely distributed of the New World treehole *Anopheles*, being found at low to moderate elevations throughout the eastern United States, from South Dakota and New York in the north to Texas and Florida in the south. Material examined: 239 specimens; 60 males, 19 male genitalia, 68 females, 1 adult, 34 pupae, 57 larvae; 24 individual rearings (3 pupal, 16 larval, 5 incomplete).

**UNITED STATES.** *Alabama:* Guntersville Lake, 28 May-27 Aug 1942, 3 ♀ [UCLA]. Ozark, Camp Rucker, 11 Mar 1943, J.G. Franclemont, 1 ♂ [CU]. Sheffield, 18 Aug 1942, J.N. Belkin, 1 ♀ [UCLA]. Wilson Dam, 10 June-19 July 1942, J.N. Belkin, 1 lp♀ (167), 1 p♂ (171), 1 p♀ (168), 2 ♂, 2 ♂ gen [UCLA]; 1942, 1 ♂ [HOPK]. *Arkansas:* Little Rock, Little Fourche Bayou, 28-29 Mar 1943, J.N. Belkin, 2 lp (440,448), 3 P [UCLA]. Scott, 2 Oct 1908, J.K. Thibault, 1 ♂, 1 ♂ gen, 1 ♀ [USNM]. *Delaware:* Bombay Hook, 17 June 1964, R.W. Lake, 1 L [USNM]; 19 Aug 1965, R.W. Lake, 1 ♀ [USNM]. Cooch's Bay, 26 June 1961, R.W. Lake (224), 1 ♂, 1 ♂ gen [USNM]. *District of Columbia:* Kenilworth, 2 July 1943, C.W. Travis, 1 ♀ [USNM]. Soldier's Home, 3 July 1943, N.E. Good and C.W. Travis, 2 ♂, 1 ♂ gen [USNM]. No locality, 12 Aug 1944, N.E. Good, 1 L [USNM]. *Georgia:* Atlanta, Fort McPherson, 19 Apr 1943, 2 L [USNM]. Milledgeville, 14 June 1950, R.H. Foote, 1 L [USNM]. Savannah, Chatham Field, 17 Aug 1944, 2 L [USNM]. *Iowa:* Ames, 10 Sept 1919, Bishopp (9085), 2 ♂, 1 ♂ gen [USNM]. Oskaloosa, 14 Sept 1933, 1 ♀ [USNM]. *Kentucky:* Louisville, G.E. Quinby, 1 ♂ [USNM]. Maxon Mill, 17 June 1935, G.E. Quinby, 1 ♂, 1 ♂ gen [USNM]. *Louisiana:* Alexandria, Esler Field, 13 Oct 1942, W.W. Wirth, 1 ♂ [USNM]. Baton Rouge, 1941-1947, W.W. Wirth, 2 ♂, 1 ♂ gen, 1 ♀, 1 L [USNM]. Lake Charles, 15 June 1943, W.W. Wirth, 1 ♂ [USNM]. Olla, May 1943, 1 ♀ [USNM]. *Maryland:* Annapolis, 6 July 1933, F.C. Bishopp, 1 ♀ [USNM]. Baltimore, July 1931, 1 L [HOPK]. Baltimore, Gwynns Falls Park, July 1931, 1 lp [HOPK]. Baltimore, Patapsco State Park, 17 Oct 1965, W.A. McDonald (UCLA 286), 1 L [UCLA]. Bethesda, 22 Aug 1944, G.B. Vogt, 1 ♂, 1 ♀ [USNM]. Cabin John, Aug-Oct 1908, F. Knab, 3 ♂, 5 ♀, 2 L [USNM]; July 1965, W.A. McDonald (UCLA 286A), 1 L [UCLA]. Great Falls, 18 May 1919, W.L. McAtee, 1 ♀ [USNM]. Plummer's Island, 23 Aug-10 Sept 1903, H.S. Barber, 2 ♀ [USNM]; 5 Sept 1904, H.S. Barber and E.A. Schwarz, 1 ♀ [USNM]; 10-13 July 1905, H.S. Barber, 2 ♂, 2 ♂ gen, 4 ♀ [USNM]; 30 Aug 1908, F. Knab, 1 ♂ [USNM]; 24 May 1912, E.A. Schwarz and H.S. Barber, 1 ♀ [USNM]; 19 June 1912, H.S. Barber, 1 ♂ [USNM]; 13 Sept (10263), eggs, 3 L [USNM]; 1 ♀ [USNM]. *Mississippi:* Agricultural College, 23 July-15 Oct 1905, G.W. Herrick, 2 ♀ [USNM]. Clinton, 30 May 1945, 1 ♂ [USNM]. Greenwood, 1928, 2 ♂, 1 ♂ gen, 3 ♀ [USNM]. Hattiesburg, Camp Shelby, 22 June 1943, 2 L [USNM]. *Missouri:* Neosho, Camp Crowder, 20 July 1942, A.B. Gurney (96), 1 ♀, 1 P [USNM]; Sept 1942, A.B. Gurney (196), 1 ♀, 1 P, 1 L [USNM]. St. Louis, Aug, A. Busck, 1 ♀ [USNM]. *New Jersey:* Chester, 8 Sept, J.M. Aldrich, 1 ♀ [USNM]. *New York:* Ithaca, 15 June-15 Oct 1932, R. Matheson, 5 ♂, 10 ♀, 1 lp (1027-1065), 5 P, 8 L [CU], 2 ♂, 1 ♂ gen, 3 ♀ [UCLA]; 1933, 1 L [CU]; 20 Aug 1935,

1 ♂, 1 A [CU]. *North Carolina*: Fayetteville, Fort Bragg, 1 Aug 1945, 1 ♀ [USNM]. Montreat, 25 June 1940, 1 ♀ [HOPK]. *Ohio*: Canton, 22 Dec 1967, T.J. Zavortink (UCLA 437), 10 lp♂ (437-30-36,39,41,43), 4 lp♀ (437-37,38,40,42), 1 p♂ (437-44), 2 ♂ gen, 1 L [UCLA]. *Oklahoma*: Idabel, 7 June 1938, L.E. Rozeboom, 1 lp (A-42) [HOPK]. *South Carolina*: Charleston, Charleston Field, 17 Aug 1944, 2 L [USNM]. Columbia, 1 Aug 1906, 1 ♂, 1 ♂ gen, 1 ♀ [USNM]. *Tennessee*: Kentucky Lake, 26 Aug 1942, 1 ♂, 1 ♂ gen [UCLA]. Paris, Camp Tyson, 21 June 1944, 2 ♂ [USNM]. Reelfoot Lake, 11 Sept 1939, T.W. Simpson and G.E. Quinby, 1 L [HOPK]. *Virginia*: Bluemont, 29 July 1904, 1 ♂ [USNM]. Dead Run, 2 July, R.C. Shannon, 3 ♂, 1 ♂ gen [USNM]. Newington, 22 Aug 1910, S.A. Rohwer, 1 ♀ [USNM]. Williamsburg, Camp Peary, July 1943, R. Bohart, 1 L [USNM]. Woodstock, 9 Aug 1904, F.C. Pratt, 2 ♂, 1 ♀ [USNM]. *Texas*: Abilene, 30 Aug 1953, R.X. Schick, 2 ♀ [UCLA]. *No Data*: (Mound 10180), 1 lp♀ (10180A3), 1 ♂, 2 ♀ [USNM]; (Mound 10253-5), 1 ♂ gen [USNM]; E.B. Johnson (37-268), 1 ♂ [USNM]; (57-3), 1 L [USNM]; (125-1), 1 ♀ [USNM]; (140-2), 1 ♀ [USNM]; (150-3), 1 ♂ gen, 1 L [USNM]; (150-4), 1 ♂ [USNM]; 1 ♀ [USNM]; 1 L [CU].

## 2. *Anopheles (Anopheles) judithae* Zavortink

Figs. 1,5,6

1969. *Anopheles (Anopheles) judithae* Zavortink, 1969:28-31. TYPE: *Holotype* ♂ with associated larval and pupal skins (UCLA 302-40), Cochise Stronghold Recreation Area, Dragoon Mountains, Cochise County, Arizona, United States, larva from oak treehole, 22 Mar 1966, T.J. Zavortink [USNM].

*Anopheles (Anopheles) barberi* of Vargas (1940:319-322); Carpenter and La Casse (1955:32-34, in part); Stone, Knight and Starcke (1959:15, in part); Carpenter (1968:72, in part).

*Anopheles barberi* of Russel, Rozeboom and Stone (1943:21,31, in part); Jenkins and Carpenter (1946:35-36, in part); Richards, Nielsen and Rees (1956:14); Rigby, Blakeslee and Forehand (1963:50); Burger (1965:396); Nielsen, Arnell and Linam (1967:76); Nielsen, Linam, Arnell and Zavortink (1968:363).

*Anopheles (Coelodiazesis) barberi* of Vargas (1943:64,65,66,67, in part); Vargas and Martinez (1956:111-113,140, in part).

FEMALE. Wing: 3.31 mm. Proboscis: 1.92 mm. Forefemur: 2.18 mm. Abdomen: about 2.1 mm. Very similar to *barberi* but differing in the following. *Head*: Interocular bristles amber; erect scales long, entirely pale white or some lateral ones dark; interocular scales numerous, white, usually none appreciably elongate. *Thorax*: Anterior acrostichal bristles amber; mesonotal scaling restricted to a small tuft of 5-20 whitish scales in center of anterior promontory; *ppl* bristles 2-5. *Legs*: Anterior forecoxal bristles 6-18.

MALE. Similar to female except for sexual differences.

MALE GENITALIA (fig. 5). *Sidepiece*: More or less cylindrical or short conical in shape, short; spicules arranged singly, in rows, or in small clumps; scales absent; parabasal spines only slightly more strongly developed than internal spine; lateral parabasal spine not flattened preapically, apex gradually attenuate and strongly recurved; internal spine more strongly developed than large setae of sidepiece, apex usually recurved. *Claspette*: Most lateral seta of ventral lobe distinctly shorter and/or finer than seta next mesad. *Clasper*: Without spicules near base.

PUPA (fig. 5). Abdomen: 2.80 mm. Trumpet: 0.37 mm. Paddle: 0.83 mm. Width of segment VIII: 0.75 mm. *Cephalothorax*: Usually lightly pigmented with darker areas less extensive than in *barberi*; hairs 1,3-C subequal in length. *Trumpet*: Light

amber in color. *Abdomen*: Usually lightly pigmented, darker areas less extensive than in *barberi*; hairs 6,7-I more or less subequal in length; 1-II,III usually single (1-3b); hair 5-III-VI short, fine, usually 2,3b; hair 5-VII usually short, fine and 2,3b, sometimes thickened and single, but then longer than 9-VII; hair 9-III-VIII lightly pigmented, concolorous with abdominal integument; 9-III more or less intermediate in diameter and length between 9-II and 9-IV; hair 0-VII small, single; 7-VII usually 2,3b (1-4), shorter than 9-VIII. *Paddle*: Usually lightly pigmented, midrib darker.

FOURTH INSTAR LARVA (fig. 6). Head: 0.67 mm. Anal Saddle: 0.30 mm. *Head*: Inner clypeals (2-C) closely approximated, separated by a distance less than that between inner and outer clypeals, single and simple; outer clypeals (3-C) far mesad of 4-C, fine, double; 11-C not plumose, single or 2,3b. *Antenna*: Spicules inconspicuous; hair 4-A simple, forked apically. *Thorax*: Integument without spicules; hair 2-P moderately long, with only a few (2-6) long lateral branches; 8-P moderately long, shaft not conspicuously thickened, lateral branches long and moderately numerous; 8-M moderately long, apical lateral branches very long; 8-T a normal plumose hair; 9-P,M,T simple. *Abdomen*: Integument without spicules; 1-I very short, usually single (1-3b), hair 1-II-VII palmate; 6-III-VI less strongly plumose than 6-I,II; hair 9-I-VI moderately developed, most branches arising near base, never stellate or plumose; 13-II-V,VII moderately developed, usually single (1-3b); hair 4-IV,V simple, single; 5-VII long with 3,4b arising from near base; 7-VII moderately long with 2,3b arising from near base; 10-VII not plumose, but with 2,3b arising from near base. *Segment VIII*: Hair 3 with 2-4b arising from base; 5 usually single. *Anal Segment*: Spicules of saddle inconspicuous, located along caudal margin and distal half of ventral margin; hair 1 simple, single.

SYSTEMATICS. *An. judithae* is the treehole *Anopheles* of the southwestern United States. Although it is quite distinct from *barberi* in all stages, it was confused with that species for nearly 30 years. The two can be easily distinguished on the basis of the diagnostic features given in the keys.

Although pupal hair 5-VII is fine and 2,3b in most specimens of *judithae*, it is thickened, single and elongate in a few individuals from nearly every collection. This is true not only in the population in the Gila River system, but also in the one in the Chisos Mountains of Texas.

BIONOMICS. *An. judithae* occurs at elevations between 600 and 2200 meters. At the upper limit of its altitudinal range it occurs in the more or less continuous xeric evergreen forest, but at lower elevations it is restricted to the narrow bands of trees lining watercourses. The immature stages have been taken only from treeholes. Like *barberi*, *judithae* overwinters in the larval stage and, as a result, is more frequently found in permanent than temporary treeholes. In contrast to *barberi*, it is not unusual to find great numbers of *judithae* larvae in the same treehole. Except for 3 males collected in a building in Sonora, Mexico (Vargas 1940:319-322), adults have not been encountered outside the laboratory.

DISTRIBUTION (fig. 1). *An. judithae* is widely distributed at moderate to high elevations in the southwestern United States and, undoubtedly, northern Mexico. In Arizona and western New Mexico it is common in the Gila River system. In Texas it has been collected in the southern Trans-Pecos area. Material examined: 1002 specimens; 200 males, 15 male genitalia, 190 females, 304 pupae, 293 larvae; 168 individual rearings (56 pupal, 102 larval, 10 incomplete).

MEXICO. *Sonora*: Imuris, 1940, A. Martinez Palacios, 1 ♂, 1 ♂ gen [ISET].

UNITED STATES. *Arizona*: Chiricahua National Monument, Headquarters, 24 Dec 1966, L.T. Nielsen (N-36-66), 1 ♂ [UTAH]; same data (N-37-66), 3 ♂, 4 ♀ [UTAH]. Cochise Stronghold Rec-

reation Area (Dragoon Mts.), 22 Mar 1966, T.J. Zavortink (UCLA 302), holotype 1p♂ (302-40), allotype 1p♀ (302-42) [USNM], 6 1p♂ (302-25,41,43,45,46,48), 5 1p♀ (302-44,47,49,51,52), 3 p♂ (302-100,101,103), 1 p♀ (302-102), 1 ♀, 1 P, 6 L [UCLA]; 23 Mar 1966, T.J. Zavortink (UCLA 306), 1 1p♀ (306-20) [UCLA]; 4 Sept 1966, T.J. Zavortink (UCLA 328), 1 1p♂ (328-22) [UCLA]; 6 Sept 1966, T.J. Zavortink (UCLA 342), 7 1p♂ (342-13,15,30,33,38,43,44), 11 1p♀ (342-10,31,32,34-37,39-42), 10 p♂ (342-100-106,109,110,113), 5 p♀ (342-107,108,111,112,114), 17 ♂, 2 ♂ gen, 25 ♀, 48 P, 27 L [UCLA]. Coronado National Memorial, Headquarters, 20 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-10-68), 2 ♂, 2 ♀ [UTAH]. Coronado National Memorial (1 mi E), 20 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-9-68), 2 ♂, 1 ♀ [UTAH]. Douglas (34 mi ENE), 13 Sept 1968, L.T. Nielsen (N-43-68), 2 ♀, 2 L [UTAH]. Fort Huachuca, 17 Sept 1962, Bates, 1 ♂ gen [USNM]. Kitt Peak National Observatory (Quinlan Mts.), 12 Sept 1968, T.J. Zavortink (UCLA 448), 1 1p♂ (448-27), 6 1p♀ (448-20-25), 1 p♀ (448-15), 1 1p (448-28) [UCLA]; 8 Sept 1969, T.J. Zavortink (UCLA 630), 1 p♂ (630-103), 1 P, 14 L [UCLA]. Lochiel (2 mi E), 21 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-13-68), 1 ♂ [UTAH]. Lochiel (11 mi E), 21 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-12A-68), 4 L [UTAH]. Nogales (13 mi NW), 21 Mar 1966, T.J. Zavortink (UCLA 297), 2 1p♀ (297-20,21) [UCLA]. Nogales (9 mi NE), 21 Mar 1966, T.J. Zavortink (UCLA 298), 3 1p♂ (298-40,42,49), 4 1p♀ (298-43,45,50,51), 3 p♂ (298-101-103), 4 1p (298-41,46-48), 1 ♂ gen, 3 ♀, 4 P, 22 L [UCLA]; same data (UCLA 299), 5 1p♂ (299-21,26,28-30), 6 1p♀ (299-20,23-25,27,31), 1 1p (299-22), 1 ♂ gen, 2 L [UCLA]. Palominas (1 mi E), 20 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-8-68), 1 ♂, 1 ♀ [UTAH]. Patagonia (1-4 mi WSW), 24 Aug 1954, W.A. McDonald (UCLA 137), 2 L [UCLA]; 6 Sept 1963, J. Burger (UCLA 413A), 2 L [UCLA]; 18 Aug 1964, J. Burger (UCLA 253), 17 ♂, 11 ♀ [UCLA]; 13 Sept 1964, J. Burger (UCLA 270), 3 L [UCLA]; 20 Sept 1964, J. Burger (UCLA 260), 17 ♂, 1 ♂ gen, 9 ♀ [UCLA]; 25 July 1965, J. Burger (UCLA 281), 4 L [UCLA]; 27 July 1965, J. Burger (UCLA 282), 5 L [UCLA]; 21 Mar 1966, T.J. Zavortink (UCLA 300), 2 1p♂ (300-30,38), 6 1p♀ (300-32-36,39), 2 p♂ (300-100,102), 2 p♀ (300-101,103), 3 ♂, 3 ♀, 6 P, 12 L [UCLA]; 5 Sept 1966, T.J. Zavortink (UCLA 333), 1 ♂, 1 P, 2 L [UCLA]; same data (UCLA 334), 1 1p♂ (334-15), 4 1p♀ (334-12-14,16), 2 p♂ (334-102,103), 3 p♀ (334-100,101,104), 1 ♀, 3 P, 2 L [UCLA]; 21 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-14-68), 18 ♂, 17 ♀, 11 L [UTAH]; 14 Sept 1968, T.J. Zavortink (UCLA 458), 1 p♀ (458-100). Portal (3 mi W), 20 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-7A-68), 1 ♂ [UTAH]. Portal (15 mi WNW), 6 Sept 1966, T.J. Zavortink (UCLA 343), 9 1p♂ (343-14,15,17,31-34,36,37), 8 1p♀ (343-12,16,19,30,38-41), 10 p♂ (343-100-104,107,109,110,113,114), 4 p♀ (343-105,108,111,112), 2 1p (343-13,35), 30 ♂, 2 ♂ gen, 25 ♀, 69 P, 39 L [UCLA]. Prescott, 19 Mar 1966, L.T. Nielsen (N-2-66), 2 ♂, 1 ♀, 1 P, 5 L [UTAH]. Prescott (7 mi NE), 1 Sept 1966, T.J. Zavortink (UCLA 315), 2 1p♂ (315-16,18), 1 ♂ gen [UCLA]. Santa Rita Mts., 20 Oct 1940, R.A. Flock, 1 ♂, 1 ♀ [CU], 1 ♂, 1 ♂ gen [UCLA]. Wickenburg (5 mi S), 18 Mar 1966, L.T. Nielsen (N-1-66), 1 ♂, 1 ♂ gen, 1 ♀, 9 L [UTAH]. *New Mexico*: Animas (15 mi S), 19 Mar 1968, L.T. Nielsen, J.H. Arnell and J.H. Linam (HA-6C-68), 1 ♀ [UTAH]. Glenwood (5 mi E), Catwalk Cmpg., 21 Mar 1967, L.T. Nielsen and J.H. Linam (N-5-67), 1 ♂, 1 ♂ gen, 1 P, 1 L [UTAH]. *Texas*: Big Bend National Park, Chisos Mts., 31 Aug 1969, T.J. Zavortink and J.A. Bergland (UCLA 603), 1 1p♂ (603-23), 4 1p♀ (603-21,22,26,33), 6 p♂ (603-100,101,102,103,108,109), 2 p♀ (603-104,110), 2 1p (603-20,27), 2 ♂ gen, 1 P, 4 L [UCLA]; 1 Sept 1969, T.J. Zavortink (UCLA 612), 2 1p♂ (612-10,11), 2 1p♀ (612-20,24), 1 L [UCLA]; same data (UCLA 613), 1 1p♂ (613-14) [UCLA].

### 3. *Anopheles (Anopheles) fausti* Vargas

Figs. 1,7,12

1943. *Anopheles (Coelodiazesis) fausti* Vargas, 1943:66-68. TYPE: *Holotype* larva, Tamazunchale, San Luis Potosi, Mexico, from treehole, Apr or May 1942, M. Macias [ISET].

*Anopheles (Anopheles) fausti* of Stone, Knight and Starcke (1959:18, in part); Belkin, Schick and

Heinemann (1965:34); Zavortink (1969:30, in part).

*Anopheles (Coelodiazesis) fausti* of Vargas and Martinez (1956:113-116,141); Senevet (1958:43); Vargas (1959:377).

*Anopheles xelajuensis* of Vargas (1942a:169-175); Russel, Rozeboom and Stone (1943:35, in part).

**FEMALE** (fig. 12). Wing: 3.36 mm. Proboscis: 2.06 mm. Forefemur: 1.98 mm. Abdomen: about 2.0 mm. A small dark species. *Head*: Integument dark brown; interocular bristles white; erect scales apparently short, dark brown except for a small patch of bright white scales in anterior dorsal region; interocular scales very long, fine, wavy, white, forming a conspicuous tuft; palpus with white scales at joints and apex, proximal scales slightly outstanding. *Thorax*: Mesonotum elongate and rather flat; mesonotal integument dark brown except for broad hoary median longitudinal stripe; pleural integument largely dark brown; mesonotal bristles not as long, strong or conspicuous as in *barberi* and *judithae*, dark except for light anterior acrostichals; center of anterior promontory with a conspicuous tuft of white scales; acrostichal scale line extending about halfway to scutellum; *ppl* bristles 3-5. *Legs*: Coxae and trochanters white, strongly contrasting with dark pleuron; anterior forecoxal bristles 13-20; femora, tibiae and tarsi dark scaled except as follows: apex of fore- and midfemora with a few white scales, more conspicuous on midfemur; apex of hindfemur with a broad ring of semierect white scales; apex of tibiae usually with a few white scales. *Wing*: Dark scaled except for a single large cream-colored apical fringe spot at ends of branches of vein R; scales of veins uniformly distributed and not grouped into dark spots; moderately scaled; scales in middle of vein 1A nearly clasping vein. *Abdomen*: Tergites and sternites dark brown.

**MALE**. As for female except for usual sexual differences.

**MALE GENITALIA** (fig. 12). *Sidepiece*: More or less cylindrical or short conical in shape, short; spicules grouped into large clumps; 1 to 5 scales usually present; parbasal spines slightly to considerably stronger than internal spine; lateral parbasal spine flattened preapically, apex attenuate and straight to recurved; internal spine as or more strongly developed than large setae of sidepiece, apex nearly straight, curved or recurved. *Claspette*: Lateral 2 setae of ventral lobe subequal in length and stoutness. *Clasper*: Sometimes with a few spicules near base of ventral surface.

**PUPA**. Unknown.

**FOURTH INSTAR LARVA** (fig. 7). Head: 0.64 mm. Anal Saddle: 0.27 mm. *Head*: Inner clypeals (2-C) closely approximated, separated by a distance much less than that between inner and outer clypeals, single, weakly plumose at least apically; outer clypeals (3-C) distinctly laterad of 4-C, fine, usually forked apically; 11-C plumose, with 9-13 lateral branches. *Antenna*: Spicules conspicuous; hair 4-A single, plumose. *Thorax*: Integument apparently not spiculate; hair 2-P moderately long, plumose, with numerous lateral branches; 8-P long, shaft not notably thickened, lateral branches short and moderately numerous; 8-M long, all lateral branches short; 8-T a normal plumose hair; 9-P,M,T barbed. *Abdomen*: Integument apparently not spiculate; hair 1-I very short, single or double, 1-II-VII palmate; 6-IV-VI shorter and less strongly plumose than 6-I-III; hair 9-I-VI distinctly plumose; 13-II-V,VII rather weakly developed with numerous (4-12) fine branches apically; 4-IV,V weakly plumose; 5-VII long, plumose; 7-VII short, plumose or forked apically; 10-VII plumose. *Segment VIII*: Hair 3 plumose; hair 5 4,5f. *Anal Segment*: Spicules of saddle moderately conspicuous, located along caudal margin and ventral margin distad of hair 1; hair 1 single, weakly plumose apically.

SYSTEMATICS. *An. fausti* is readily separated from all species except *arboricolus* in all known stages by the characters given in the keys. It is distinguished from *arboricolus* only in the larval stage; the differences are indicated in the key and the systematics section of *arboricolus*.

The distal portion of many of the larval hairs of *fausti* is plumose or forked; because of the fineness of these branches it has not been possible to count them accurately.

In contrast to the other austral species of New World treehole *Anopheles*, *fausti* appears to be a low elevation form.

BIONOMICS. The larvae of the type series were collected in treeholes at elevations of less than 200 meters in a tropical rain forest. Nothing is known of the habits of the adults.

DISTRIBUTION (fig. 1). Known definitely only from Tamazunchale and environs, at the base of the Sierra Madre Oriental in central Mexico. I have not seen the material upon which the Nicaragua record in Stone, Knight and Starcke (1959: 18) is based. Material examined: 11 specimens; 2 males, 3 male genitalia, 2 females, 4 larvae.

MEXICO. *San Luis Potosi*: Tlapexhuacan, near Tamazunchale, Apr 1942, M. Macias, 1 ♀ [HOPK], 2 ♂, 1 ♂ gen, 1 ♀, 1 L [ISET], 2 ♂ gen, 3 L [USNM].

#### 4. *Anopheles (Anopheles) arboricolus* Zavortink, n.sp.

Figs. 1,8,12

TYPES: *Holotype* larva (PA 647), "Bajo Grande," near Cerro Punta, Chiriqui, Panama, elevation about 2070 meters, from treehole, 18 Mar 1964 [USNM]. *Paratypes*: 5 larvae (PA 647), same data as holotype [UCLA].

*Anopheles (Anopheles) fausti* of Stone, Knight and Starcke (1959:18, in part); Zavortink (1969: 30, in part).

?*Anopheles (Anopheles) xelajuensis* of Lane (1953:171-172, in part); Stone, Knight and Starcke (1959:30, in part).

?*Anopheles xelajuensis* of Galindo (1947:23).

FEMALE. Unknown.

MALE. Wing: 3.67 mm. Proboscis: 2.54 mm. Forefemur: 2.23 mm. Abdomen: about 2.3 mm. A small dark species. Very similar to *fausti* and possibly not distinguishable from it since the following minute differences may be individual rather than specific. *Head*: Erect scales short, especially mesally, patch of bright white scales larger than in *fausti*. *Legs*: Femora, tibiae and tarsi dark scaled except for a ring of semierect white scales at apex of hindfemur, this ring narrower and with the scales less outstanding than in *fausti*.

MALE GENITALIA (fig. 12). Probably indistinguishable from *fausti*. *Sidepiece*: More or less short conical in shape, short; parbasal spines considerably stronger than internal spine; internal spine more strongly developed than large bristles of sidepiece, apex recurved. *Clasper*: Without spicules near base.

PUPA. Unknown.

FOURTH INSTAR LARVA (fig. 8). Head: 0.83 mm. Anal Saddle: 0.35 mm. *Head*: Inner clypeals (2-C) closely approximated, separated by a distance much less than that between inner and outer clypeals, single and simple; outer clypeals (3-C) distinctly laterad of 4-C, fine, single or forked apically; 11-C plumose, with 6-8 lat-

eral branches. *Antenna*: Spicules apparently absent; hair 4-A simple, single or double. *Thorax*: Integument apparently without spicules; hair 2-P moderately long, plumose, with numerous lateral branches; 8-P moderately long, shaft very thick, lateral branches short and numerous; 8-M moderately long, all lateral branches moderately long; 8-T a normal plumose hair; 9-P,M simple; 9-T very weakly plumose, with 4-6 lateral branches. *Abdomen*: Integument apparently without spicules; hair 1-I very short, usually single (1-3b), hair 1-II multiple or palmate, 1-III-VII palmate; 6-I-VI similar in development and length; 9-I,II moderately developed, with multiple branches arising near base, 9-III-VI distinctly plumose; 13-II-V,VII moderately developed, usually 3b (2-6); hair 4-IV,V usually weakly plumose; 5-VII moderately long with 3,4b usually arising near base; 7-VII short with 4-7b usually arising near base; 10-VII plumose. *Segment VIII*: Hair 3 single, simple; hair 5 usually with 2,3b from base. *Anal Segment*: Spicules on saddle inconspicuous, located along ventral margin distad of hair 1 and along caudal edge; hair 1 single, simple.

SYSTEMATICS. *An. arboricolus* is at present definitely known from a single collection of 3 fourth and 3 third instar larvae from the Chiriqui Volcano region of western Panama. Although these larvae agree with those of *fausti* in many significant details, they differ in so many others that I do not hesitate to recognize them as a distinct species in the absence of associated adults. In addition to the characters given in the key, larvae of the 2 species differ in morphology of hairs 4-A, 8-P,M, 9-P,M,T, 6-IV-VI, 5-VII and 3-VIII. The description of the male and male genitalia of *arboricolus* is based on a single individual; the presumptive association of this specimen with the larvae is probably correct since the specimen is from the same region as the larvae and, like them, similar to *fausti*. In fact, as indicated in the description above, adults and male genitalia of *fausti* and *arboricolus* are probably indistinguishable.

The original record of *xelajuensis* from the Chiriqui Volcano region of Panama (Galindo, 1947:23) and the subsequent ones based on it (Lane, 1953:172; Stone, Knight and Starcke, 1959:30) possibly refer to *arboricolus*. The record of *fausti* from Panama (Stone, Knight and Starcke, 1959:18) is apparently based on the same male that I have seen and tentatively associated with *arboricolus*.

BIONOMICS. The larvae of the type series were collected in a treehole at an elevation of about 2070 meters. The report of finding 6 males and 4 females of *xelajuensis* resting in hollow trees at an elevation of about 1900 meters on Volcan Chiriqui (Galindo, 1947:23) may refer to this species.

DISTRIBUTION (fig. 1). Currently known only from high elevations in the Chiriqui Volcano area of western Panama. Material examined: 8 specimens; 1 male, 1 male genitalia, 6 larvae.

PANAMA. *Chiriqui*: "Bajo Grande," near Cerro Punta, type series, see above. El Volcan Chiriqui, 30 June 1943, T.H.G. Aitken, 1 ♂, 1 ♂ gen [USNM].

## 5. *Anopheles (Anopheles) xelajuensis* de Leon

Figs. 1,9,10,12

1938. *Anopheles xelajuensis* de Leon, 1938:421-423. TYPE: *Holotype* ♂, Cerro Quemado, near Quezaltenango, Quezaltenango, Guatemala, 2 Jan 1936, J. Romeo de Leon [ESPG].

*Anopheles (Anopheles) xelajuensis* of Lane (1953:171-172, in part); Stone, Knight and Starcke (1959:30, in part); Belkin, Schick and Heinemann (1965:28); Zavortink (1969:30).

*Anopheles xelajuensis* of Komp (1941:92,96); Russel, Rozeboom and Stone (1943:35, in part); Forattini (1961:174,180,181).

*Anopheles (Coelodiazesis) xelajuensis* of Vargas and Martinez (1956:116-119,142); Vargas (1959:377).

*Anopheles (Russellia) xelajuensis* of Vargas (1943:65,67,68-70); Senevet (1958:44).

FEMALE (fig. 12). Wing: 5.16 mm. Proboscis: 2.92 mm. Forefemur: 2.75 mm. Abdomen: about 2.6 mm. A large dark species. *Head*: Integument dark brown; interocular bristles whitish; erect scales long, mostly black, anterior ones brilliant white; interocular scales white, much elongate, forming a conspicuous tuft; palpus entirely dark scaled, basal scales semierect. *Thorax*: Mesonotum long and only slightly arched; mesonotal integument dark brown with a broad hoary median longitudinal stripe; pleural integument dark brown; anterior mesonotal bristles not as long, strong or conspicuous as in *barberi* and *judithae*, dark except for light anterior acrostichals; narrow white scales in tuft in center of anterior promontory and extending through anterior third of acrostichal line; *ppl* bristles 3-5. *Legs*: Coxae and trochanters white; anterior forecoxal bristles 8-16; femora, tibiae and tarsi dark scaled except as follows: femora with apical white scales, few on foreleg, many, forming a conspicuous ring, on hindleg; fore- and midtibiae with a few white scales at apex; hindtibia with long broad apical white patch covering anterior, dorsal and posterior surfaces. *Wing*: Largely dark scaled; apex of costa and vein  $R_1$  with yellowish-white scales; 4 fringe spots usually present, 1 large, extending from end of costa to vein  $R_{4+5}$ , 3 smaller, at ends of veins  $M_{1+2}$ ,  $M_{3+4}$  and  $Cu_1$ ; dark scales not uniformly distributed, but grouped into strong spots at base of veins  $R_s$  and  $R_{4+5}$  and at furcation of veins  $R_{2+3}$ ,  $M$  and  $Cu$ ; profusely scaled; scales in middle portion of vein 1A somewhat spreading. *Abdomen*: Tergites black, sternites black with basal white band.

MALE. As for female except for sexual characters.

MALE GENITALIA (fig. 9). *Sidepiece*: More or less cylindrical in shape, long; spicules arranged singly, in rows or in small clumps; scales numerous, 6-16; parabasal spines stronger than internal spine; lateral parabasal spine not flattened preapically, apex gradually attenuate and recurved; internal spine slightly stronger than large bristles of sidepiece, apex curved. *Claspette*: Lateral 2 setae of ventral lobe subequal in stoutness, but outermost usually shorter. *Clasper*: With at least a few spicules near base of ventral surface.

PUPA (fig. 9). Abdomen: not measured. Trumpet: 0.55 mm. Paddle: 1.19 mm. Width of segment VIII: 0.92 mm. *Cephalothorax*: Moderately pigmented with darker areas more extensive than in *powderi*; hair 3-C much longer than 1-C. *Trumpet*: Brown. *Abdomen*: Moderately pigmented, darker areas more extensive than in *powderi*; hair 6-I much longer than 7-I; hair 1-II,III multiple (3-5b); hair 5-III,IV short, fine, usually 3,4b; hair 5-V-VII thickened, much longer than hair 9 of corresponding segment, and with 3-5 fine lateral or apical branches; 9-III-VIII moderately pigmented, concolorous with to slightly darker than abdominal integument; 9-III approaching 9-IV in both diameter and length; 0-VII enlarged, 5,6b; hair 7-VII single, longer than 9-VIII. *Paddle*: Moderately pigmented, midrib not darker.

FOURTH INSTAR LARVA (fig. 10). Head: 0.90 mm. Anal Saddle: 0.39 mm. *Head*: Inner clypeals (2-C) closely approximated, separated by a distance much less than that between inner and outer clypeals, single and simple; outer clypeals (3-C) distinctly laterad of 4-C, single, thickened; 11-C not plumose, with 2-5b from near base. *Antenna*: Spicules inconspicuous; hair 4-A single and simple. *Thorax*: Integu-



ment, at least on ventral surface, spiculose; hair 2-P stellate, 9-15b; hair 8-P moderately long, shaft very stout, lateral branches very short and moderately numerous; 8-M moderately long, basal lateral branches very long; 8-T with thickened shaft, not plumose to apex, distal end blunt; 9-P,M,T barbed. *Abdomen*: Integument, at least on more posterior segments, spiculose; 1-I-VII stellate; 6-IV-VI less strongly plumose than 6-I-III; hair 9-I-VI stellate, very strongly developed; 13-II-V,VII strongly developed, stellate; 4-IV,V simple, single or double; 5,7-VII stellate, 8-11b; hair 10-VII stellate, 4-6b. *Segment VIII*: Hair 3 with 3-6 very stout branches from base; hair 5 stellate, 18-22b. *Anal Segment*: Spicules on saddle very conspicuous, located on all but basal portion of saddle; hair 1 with 3-5b, usually from base.

**SYSTEMATICS.** *An. xelajuensis* is the most differentiated New World treehole *Anopheles*. The most striking characteristics of the species have been indicated in the keys and the systematics chapter.

According to the original description, which is based on a single male from Guatemala, the hindtibia of *xelajuensis* is entirely dark scaled. The adults from Mexico examined during this study have a conspicuous large white patch at the apex of the hindtibia. It is possible that these specimens represent a different species, but this cannot be determined until additional material, especially topotypic *xelajuensis*, is obtained.

**BIONOMICS.** Larvae of *xelajuensis* have been collected in a treehole at an elevation of 2500 meters. According to Vargas (1943:70) the larvae feed on bottom sediments and spend relatively little time at the surface, the pupal stage lasts 12 to 15 days and females readily bite humans. The holotype male was collected between rocks in an oak forest in the highlands of Guatemala.

**DISTRIBUTION** (fig. 1). Known only from high elevations in the Sierra Madre del Sur of southern Mexico and the Sierra Madre in Guatemala. The Panama records of Galindo (1947:23), Lane (1953:172) and Stone, Knight and Starcke (1959:30) refer to *arboricolus* or *powderi*. Material examined: 13 specimens; 2 males, 3 male genitalia, 1 female, 1 pupa, 6 larvae.

**MEXICO.** *Oaxaca*: Galera Vieja, between Ixtlan and Tepanzacoalco, Sept 1942, M. Macias, 1 ♂ gen, 1 L [CU], 2 ♂, 2 ♂ gen, 1 ♀, 2 L [ISET], 1 P, 2 L [USNM], 1 L [UCLA].

## 6. *Anopheles (Anopheles) powderi* Zavortink, n.sp.

Figs. 1,11

**TYPE:** *Holotype* ♀ with associated pupal skin (CR 50-102), about 10 km SE of La Sierra, San Jose, Costa Rica, elevation about 2400 meters, from rothole in fallen tree, 24 Nov 1962, C.L. Hogue and W.A. Powder [USNM]. This species is dedicated to William A. Powder, in recognition of his contributions to the "Mosquitoes of Middle America" project.

?*Anopheles (Anopheles) xelajuensis* of Lane (1953:171-172, in part); Stone, Knight and Starcke (1959:30, in part).

?*Anopheles xelajuensis* of Galindo (1947:23).

**FEMALE** (fig. 11). Wing: 5.15 mm. Proboscis: 3.13 mm. Forefemur: 2.88 mm. Abdomen: about 2.7 mm. A large dark species. Quite similar to *xelajuensis*, differing mostly in ornamentation of leg and wing. *Head*: Interocular bristles amber. *Thorax*: Whitish acrostichal scales extending about halfway to scutellum. *Legs*: Femora, tibiae and tarsi dark scaled except for conspicuous ring of semierect white scales at

apex of hindfemur and a few white scales at apex of hindtibia. *Wing*: Veins and fringe dark scaled except for a single large apical fringe spot extending from end of vein  $R_1$  to end of vein  $M_{1+2}$ ; scales of veins uniformly distributed and not grouped into dark spots; profusely scaled; scales in middle portion of vein 1A wide spreading. *Abdomen*: Tergites and sternites black.

MALE and MALE GENITALIA. Unknown.

PUPA (fig. 11). Abdomen: 4.75 mm. Trumpet: 0.54 mm. Paddle: 1.27 mm. Width of segment VIII: 1.11 mm. *Cephalothorax*: Lightly pigmented with darker areas less extensive than in *xelajuensis*; hairs 1,3-C subequal in length. *Trumpet*: Light amber in color. *Abdomen*: Lightly pigmented, darker areas less extensive than in *xelajuensis*; hairs 6,7-I subequal in length; 1-II,III multiple; 5-III-VII short, fine, usually 2,3b; hair 9-III-VIII lightly pigmented, more or less concolorous with abdominal integument; 9-III approaching 9-IV in diameter and length; 0-VII small, single; 7-VII double, shorter than 9-VIII. *Paddle*: Very lightly pigmented, midrib not noticeably darker.

LARVA. Unknown.

SYSTEMATICS. *An. powderi* is known from a single female with its associated pupal skin. The adult, as indicated in the key, is adequately distinct but the pupa, except for its much larger size, is scarcely differentiated from that of *judithae*. *An. xelajuensis* is the only other New World treehole *Anopheles* of comparable size.

This species could extend through the Cordillera de Talamanca into western Panama, and, if so, it might be the *xelajuensis* of Galindo (1947:23), Lane (1953:172) and Stone, Knight and Starcke (1959:30).

BIONOMICS. The pupa of *powderi* was taken from a rothole in a fallen tree at an elevation of about 2400 meters in a cloud forest.

DISTRIBUTION (fig. 1). Presently known solely from the holotype which was collected high in the Cordillera de Talamanca in southern Costa Rica. Material examined: 2 specimens; 1 female, 1 pupa; 1 pupal rearing.

COSTA RICA. *San Jose*: La Sierra (10 km SE), holotype, see above.

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## FIGURES

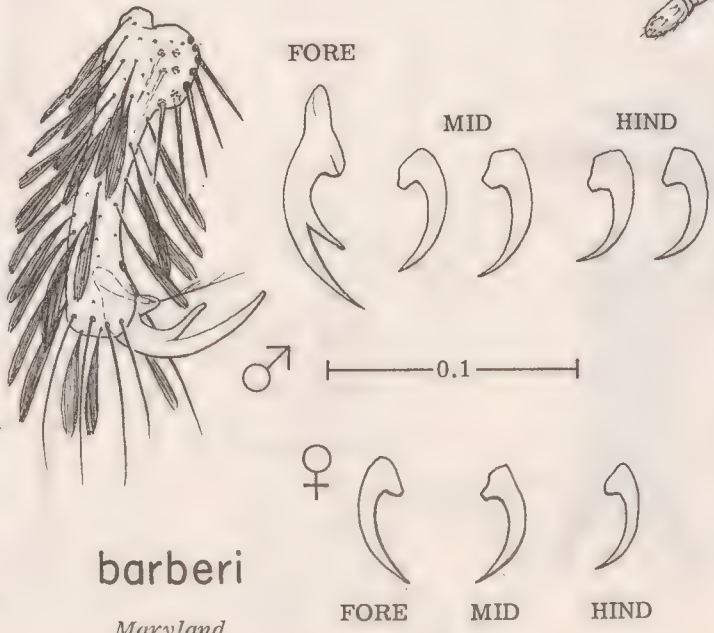
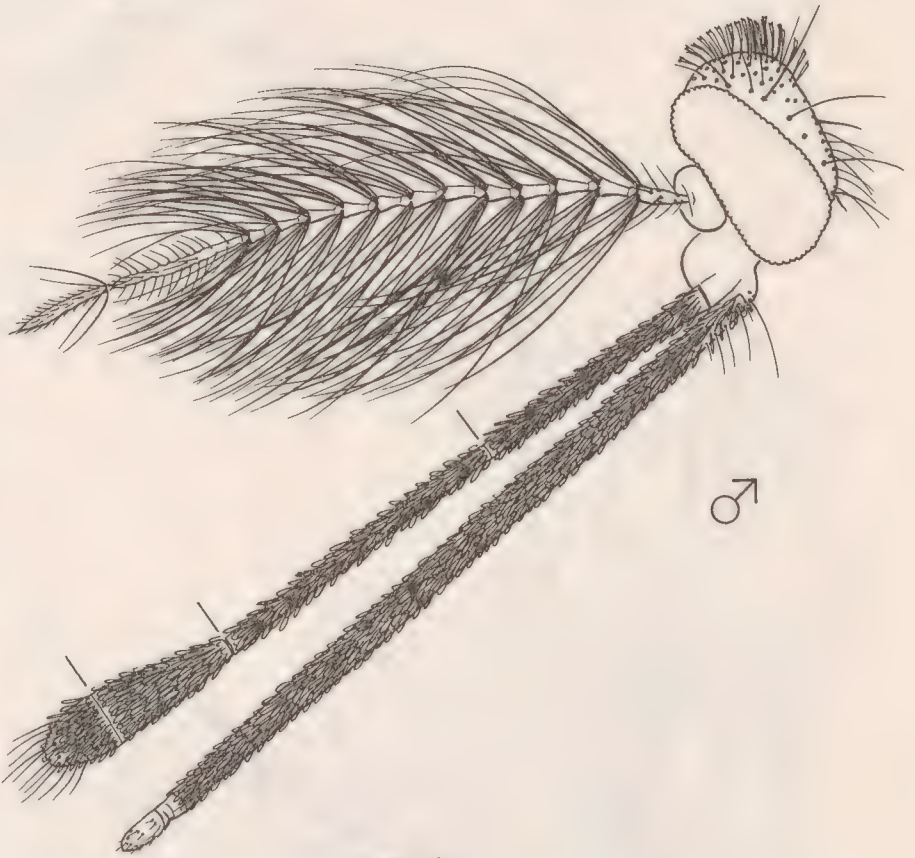
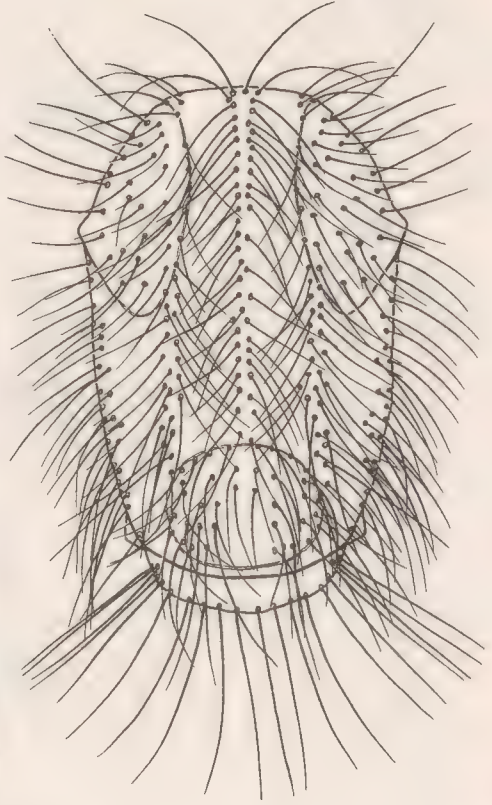
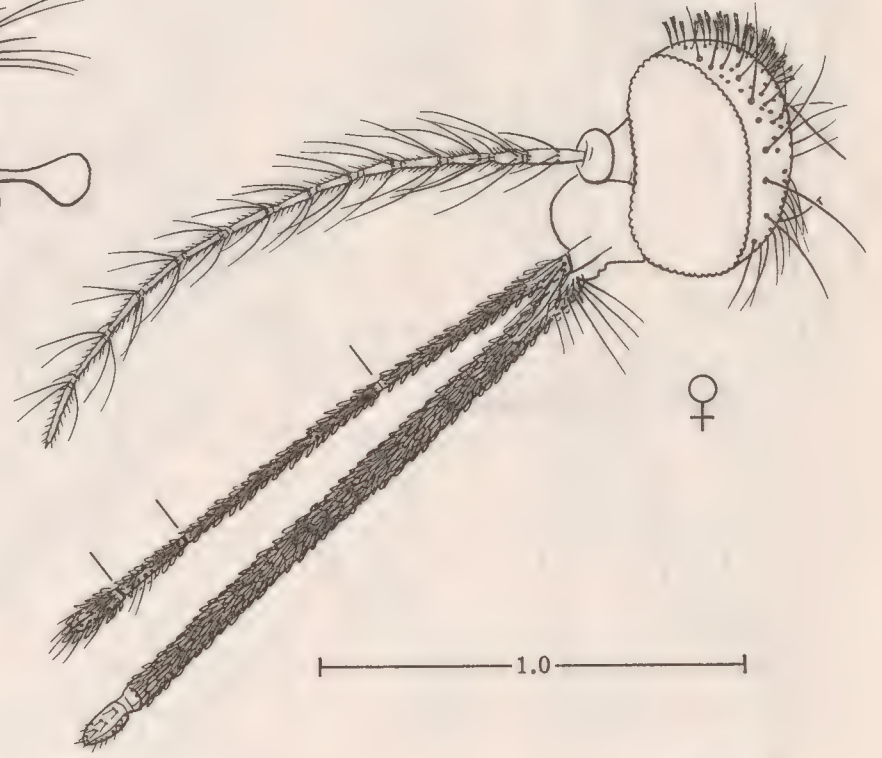
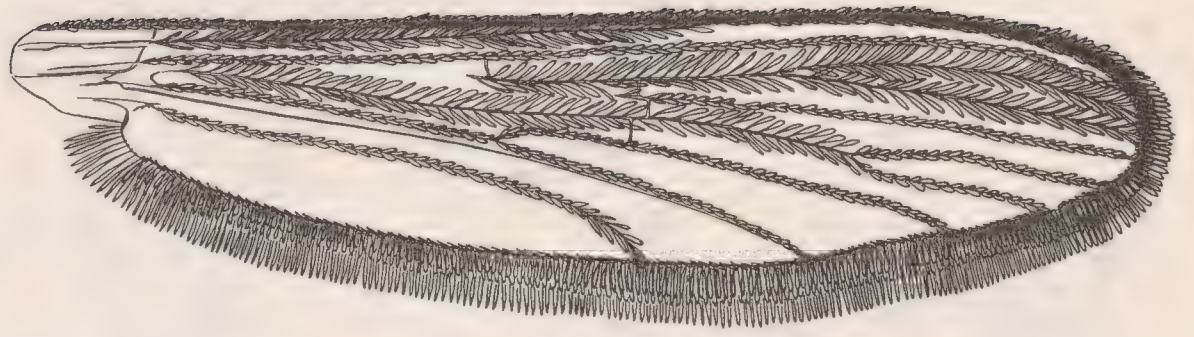
1. Distribution of collections examined
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3. *Anopheles (An.) barberi*; male genitalia and pupa
4. *Anopheles (An.) barberi*; larva
5. *Anopheles (An.) judithae*; male genitalia and pupa
6. *Anopheles (An.) judithae*; larva
7. *Anopheles (An.) fausti*; larva
8. *Anopheles (An.) arboricolus*; larva
9. *Anopheles (An.) xelajuensis*; male genitalia and pupa
10. *Anopheles (An.) xelajuensis*; larva
11. *Anopheles (An.) powderi*; pupa and pleuron and mesonotum of adult
12. *Anopheles (An.) arboricolus*; male genitalia. *Anopheles (An.) fausti*; male genitalia, wing and hindleg. *Anopheles (An.) xelajuensis*; wing and hindleg.



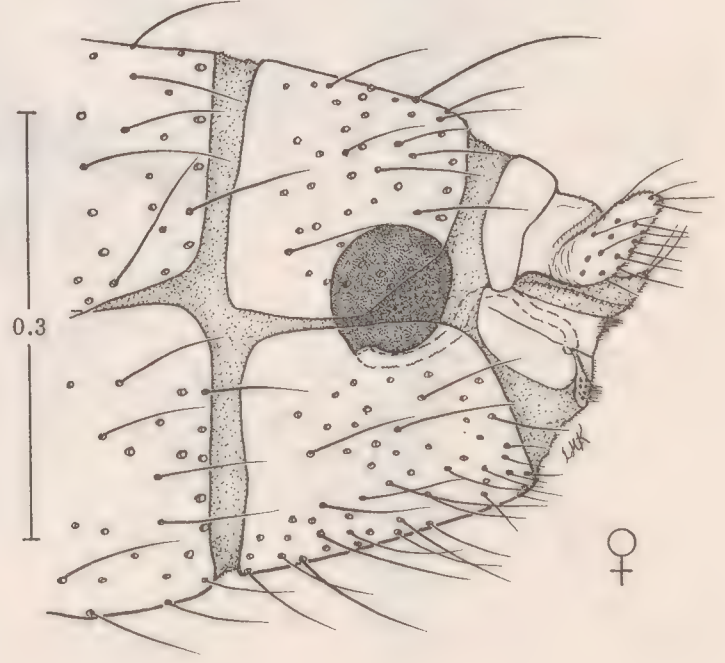
FORE MID HIND

# ANOPHELES

## Fig. 2

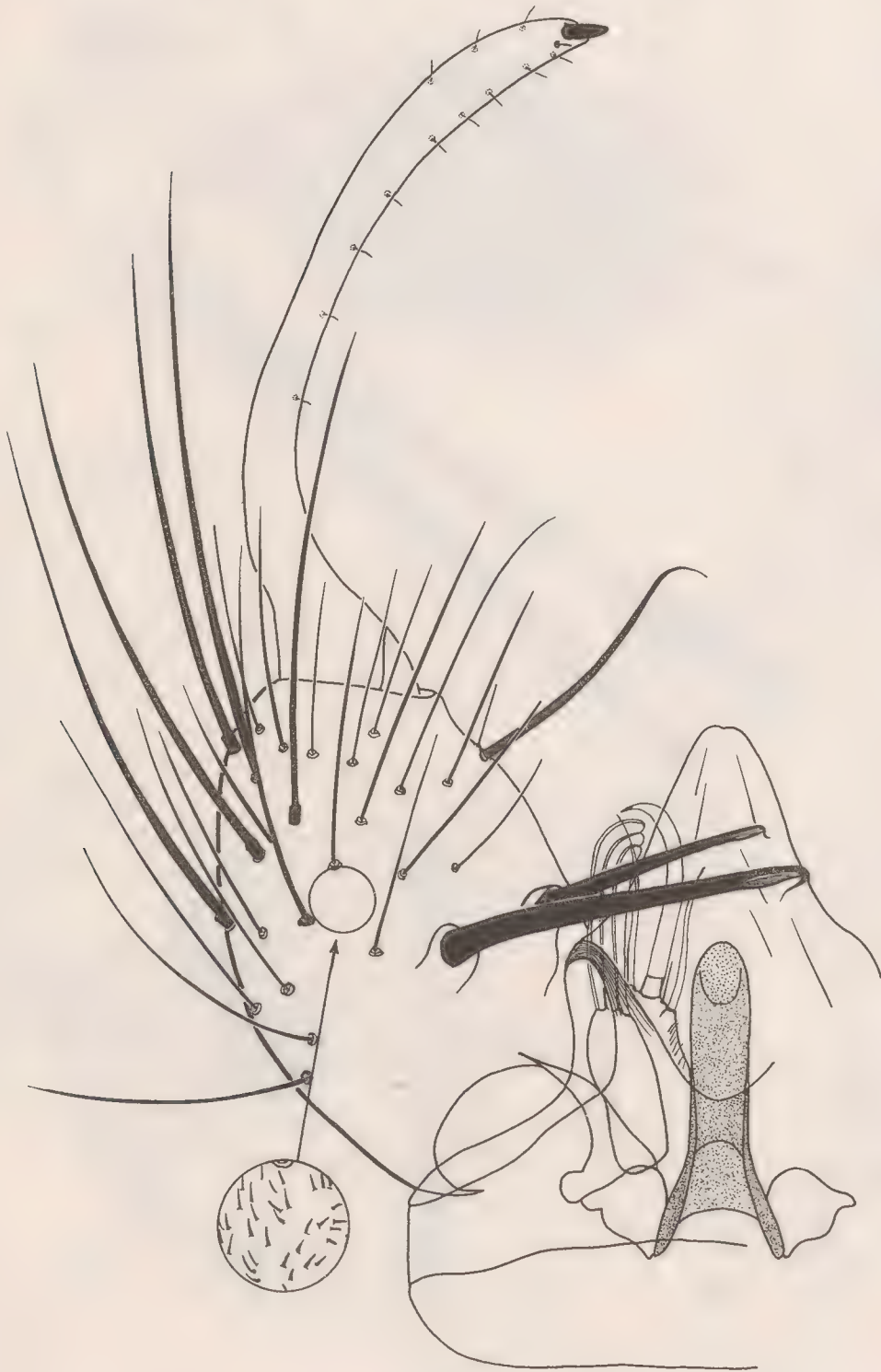
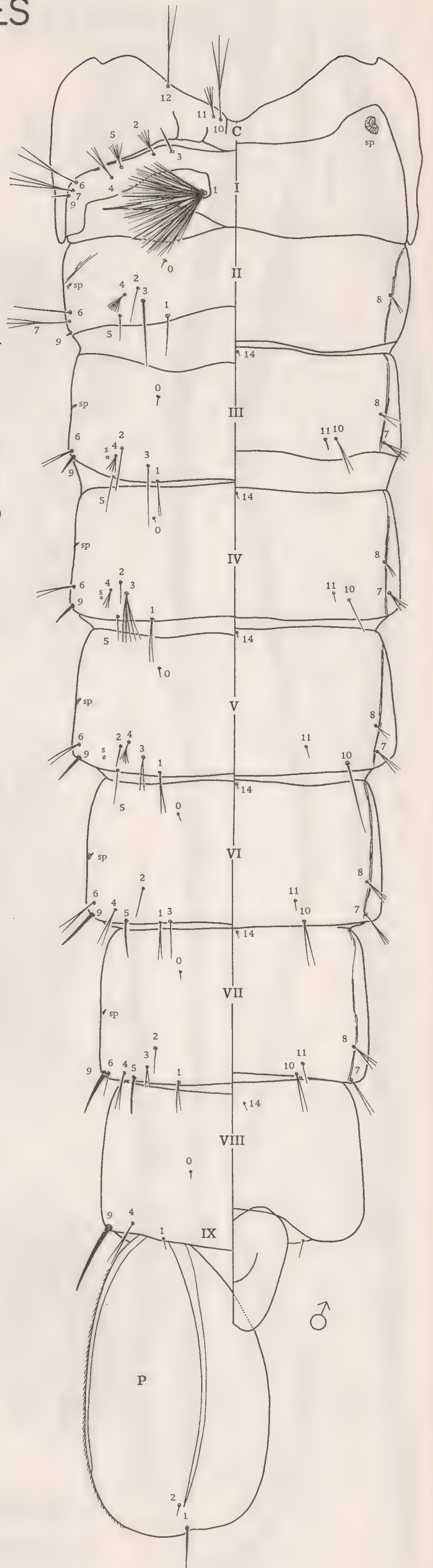
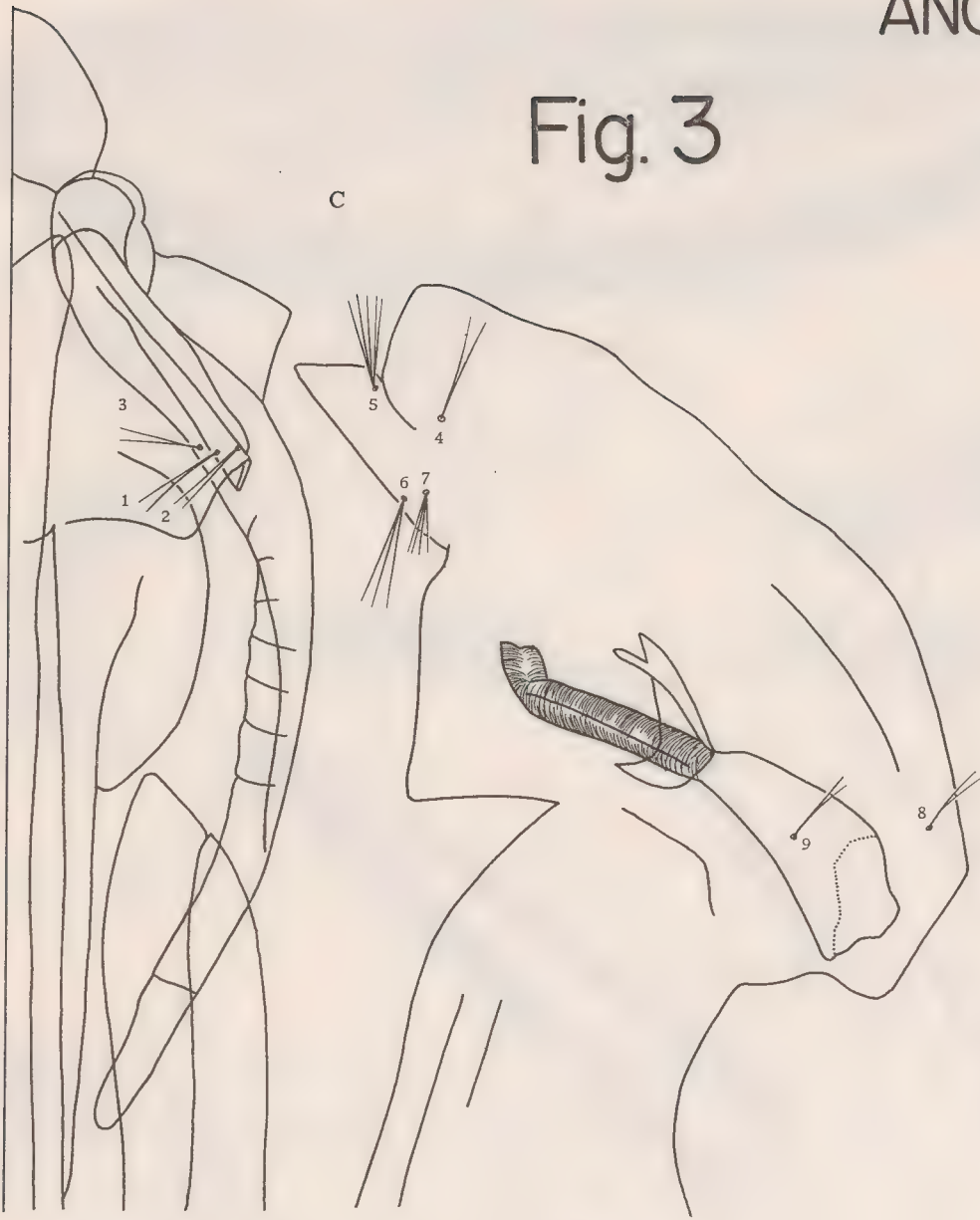


**barberi**  
Maryland  
United States



ANOPHELES

Fig. 3



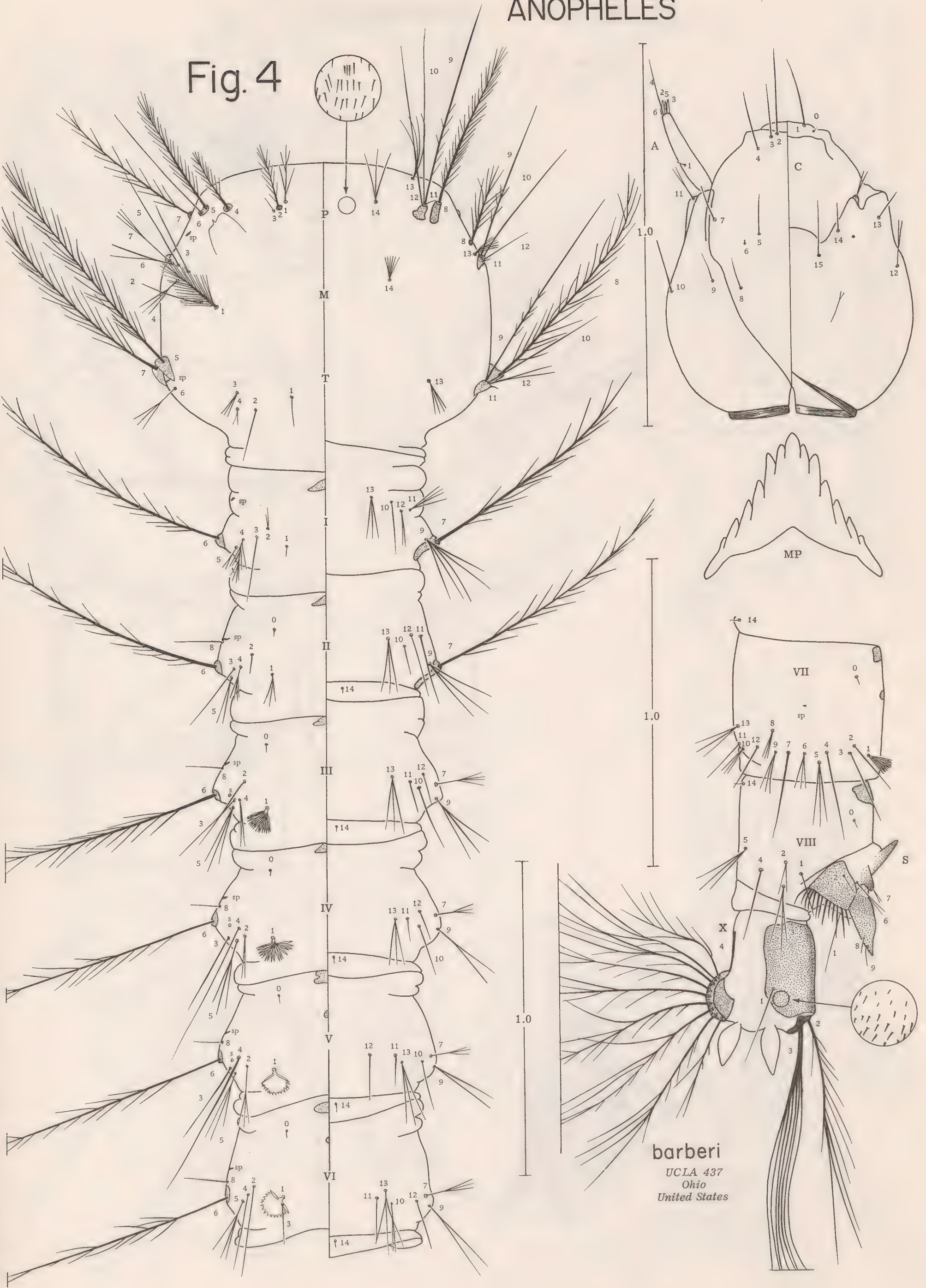
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**barberi**  
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United States



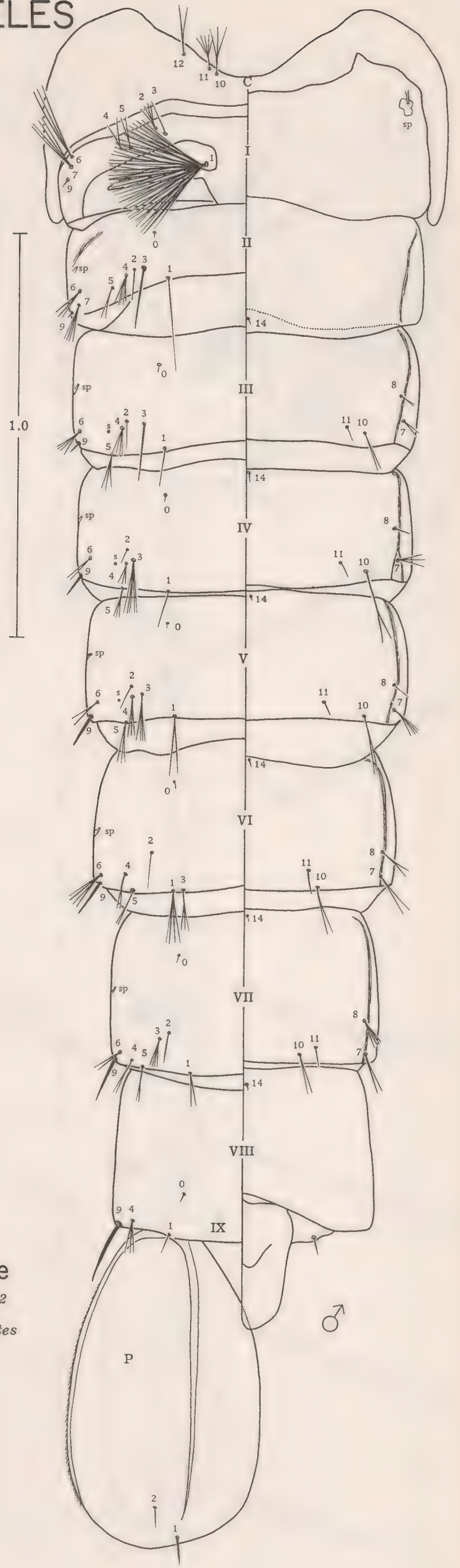
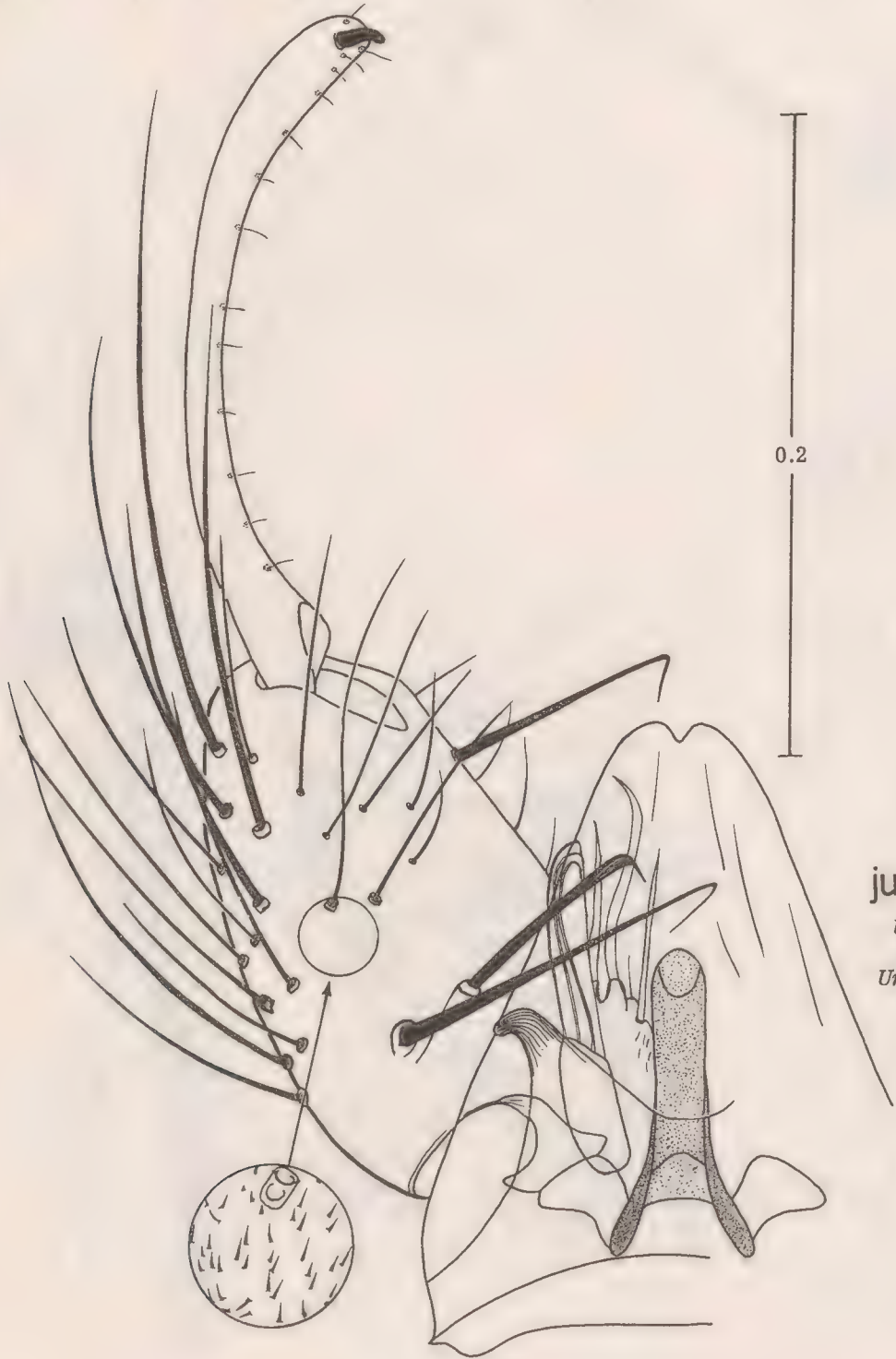
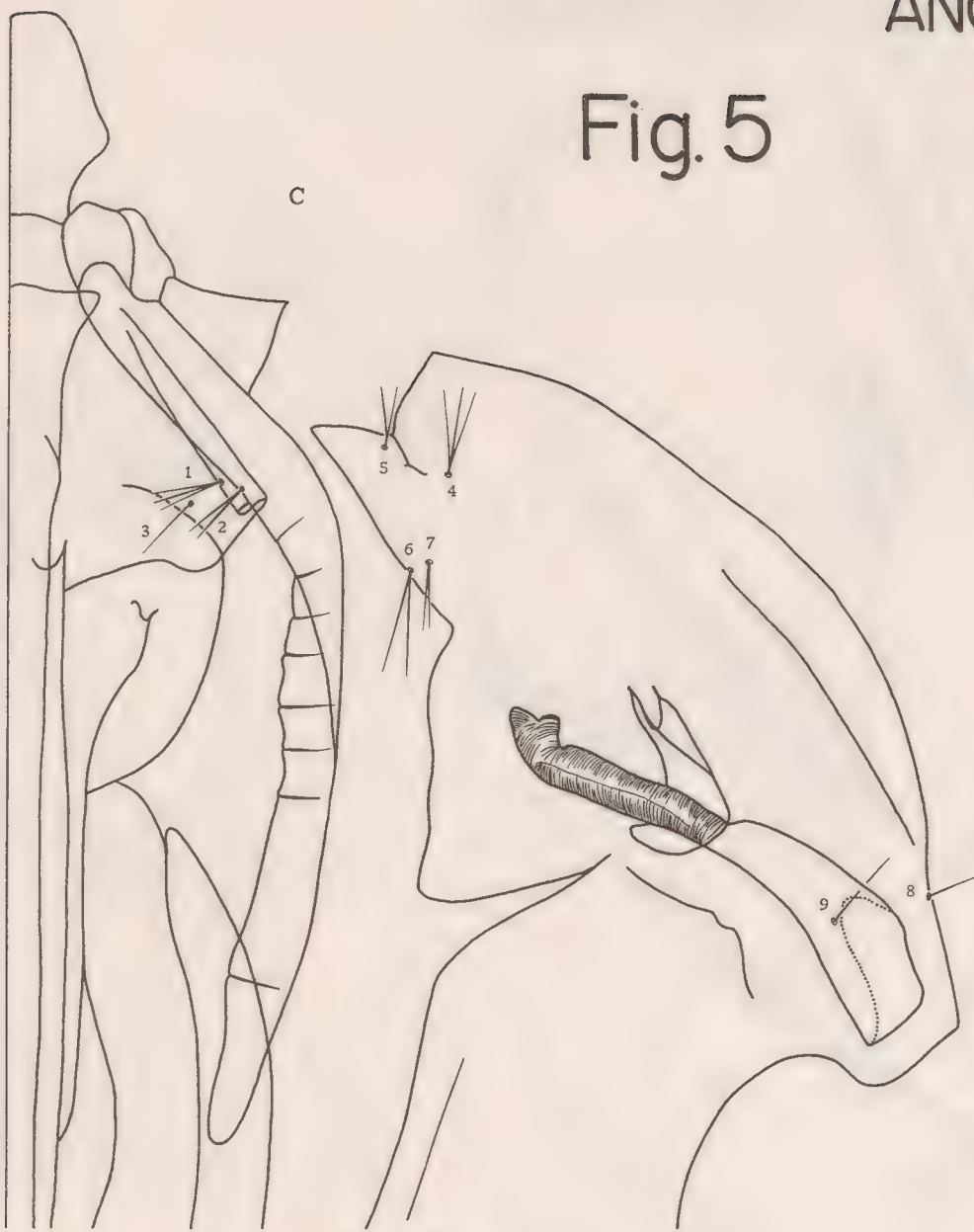
ANOPHELES

Fig. 4



ANOPHELES

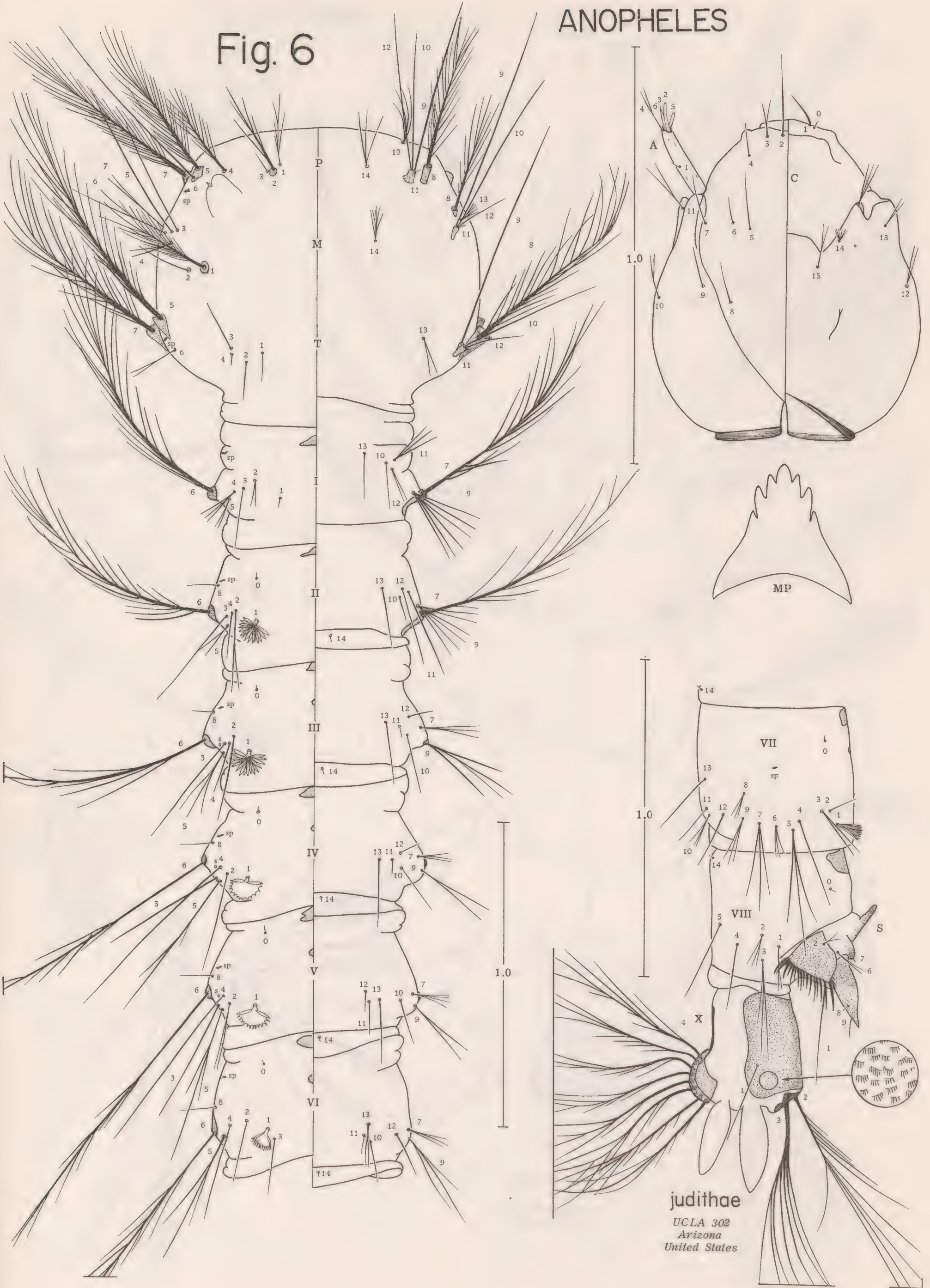
Fig. 5



judithae  
UCLA 302  
Arizona  
United States

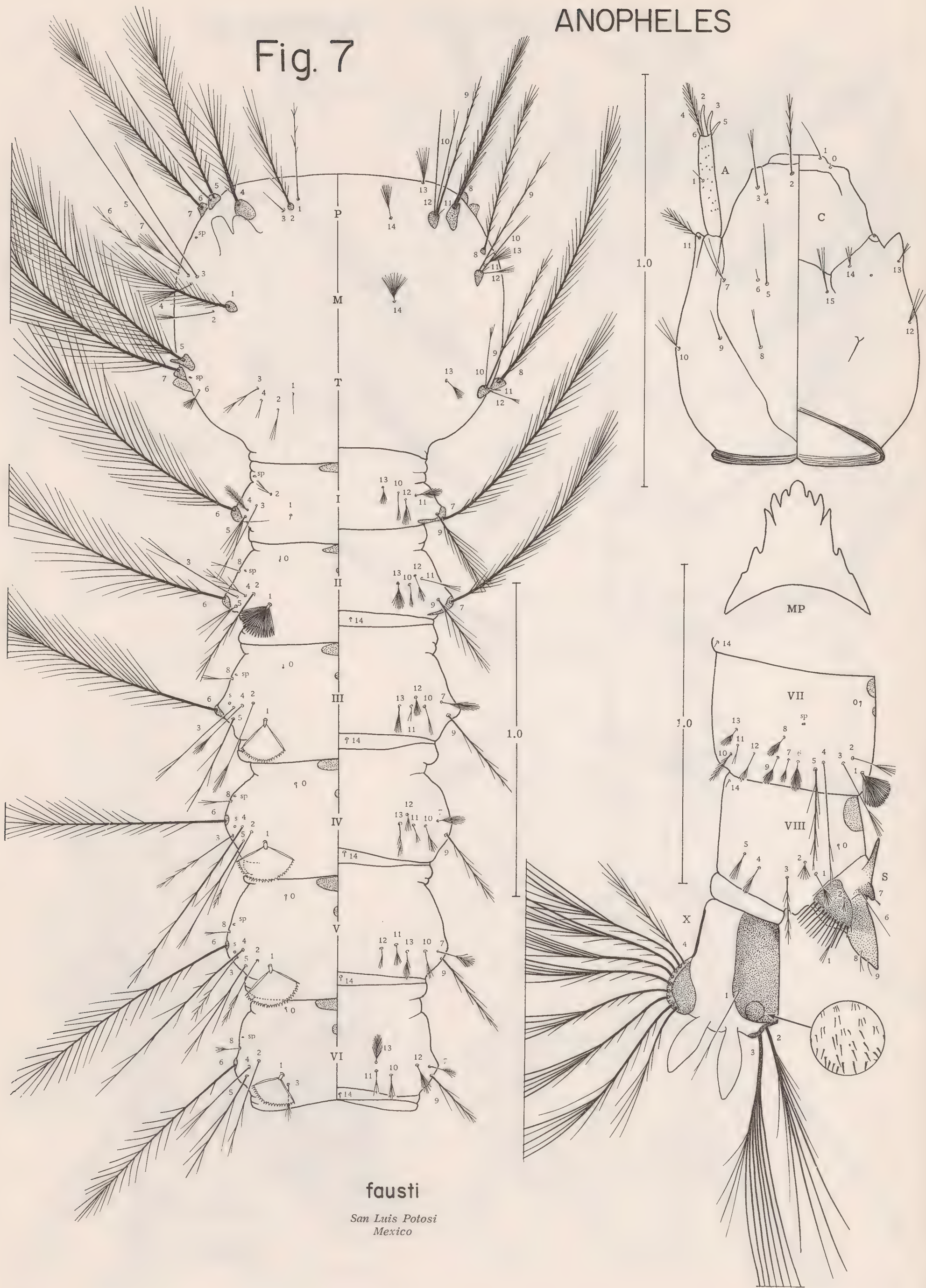
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Fig. 6



ANOPHELES

Fig. 7

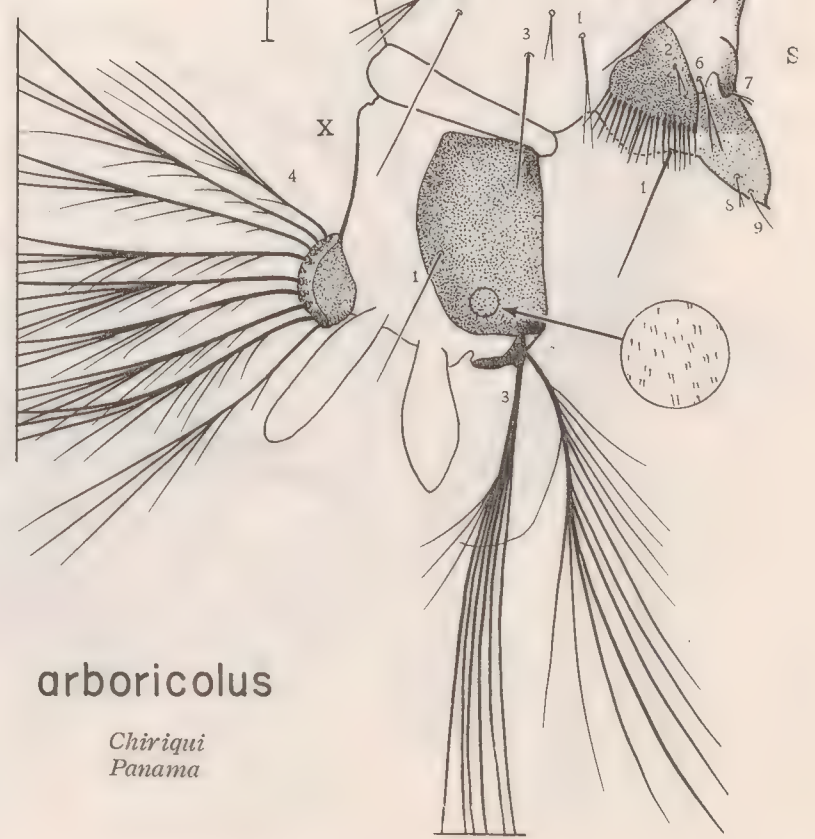
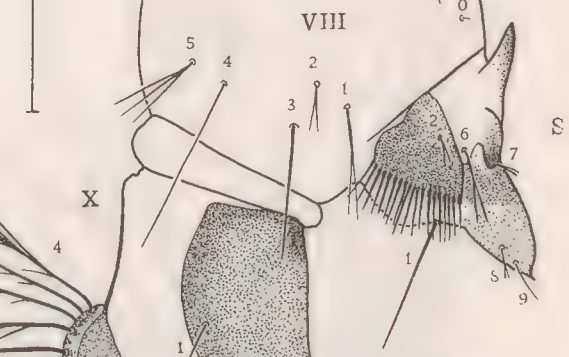
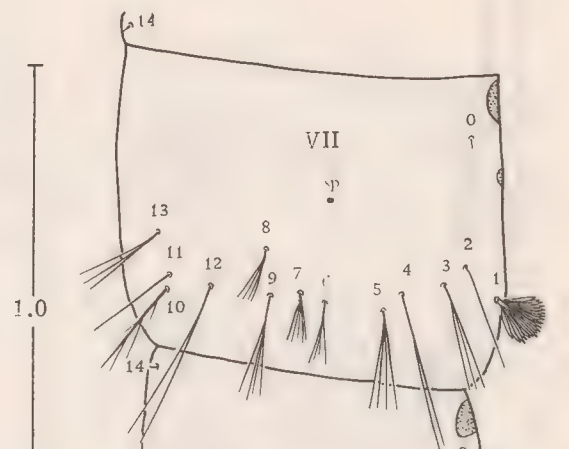
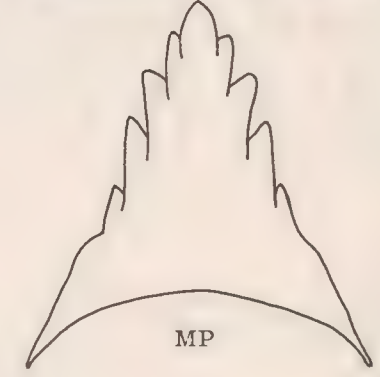
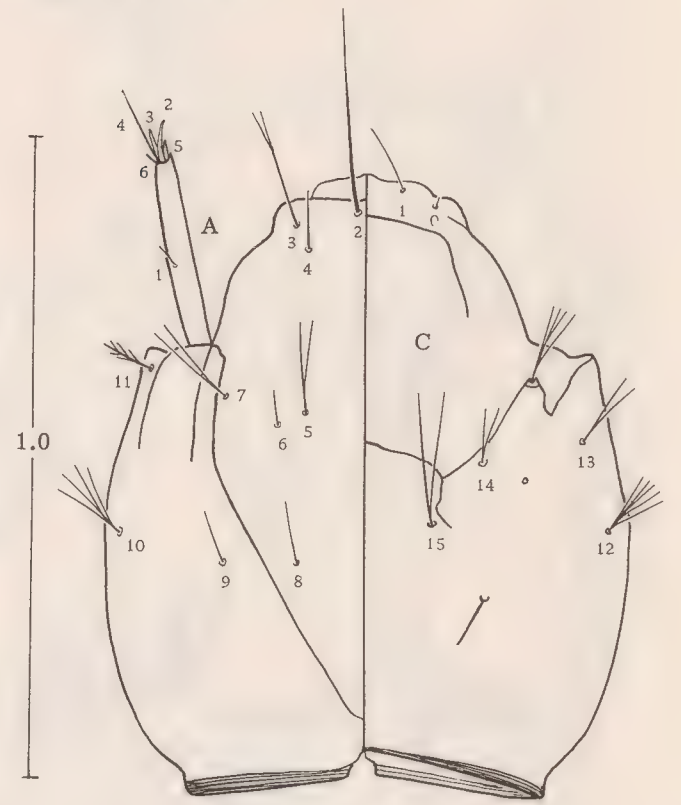
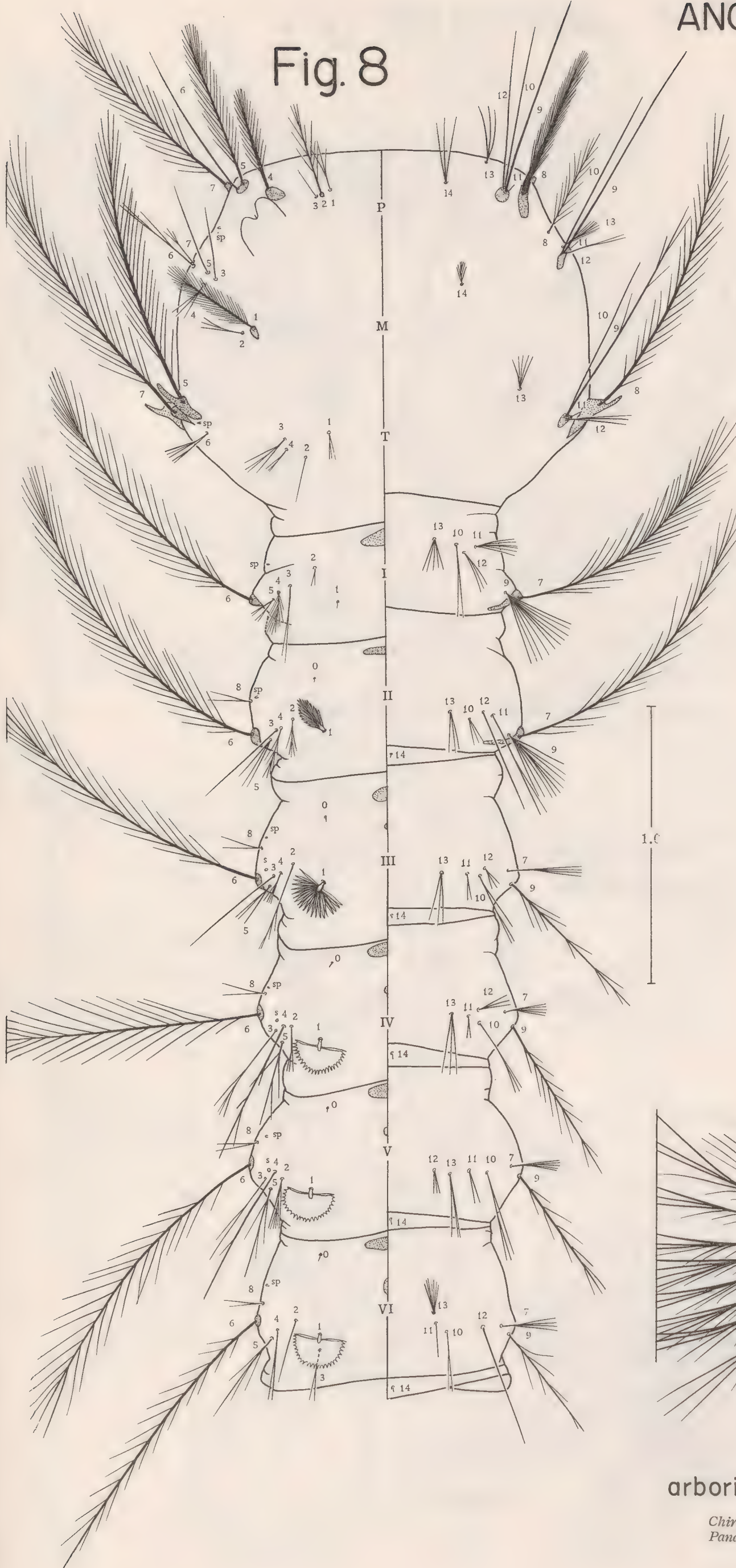


**fausti**

*San Luis Potosi  
Mexico*

ANOPHELES

Fig. 8

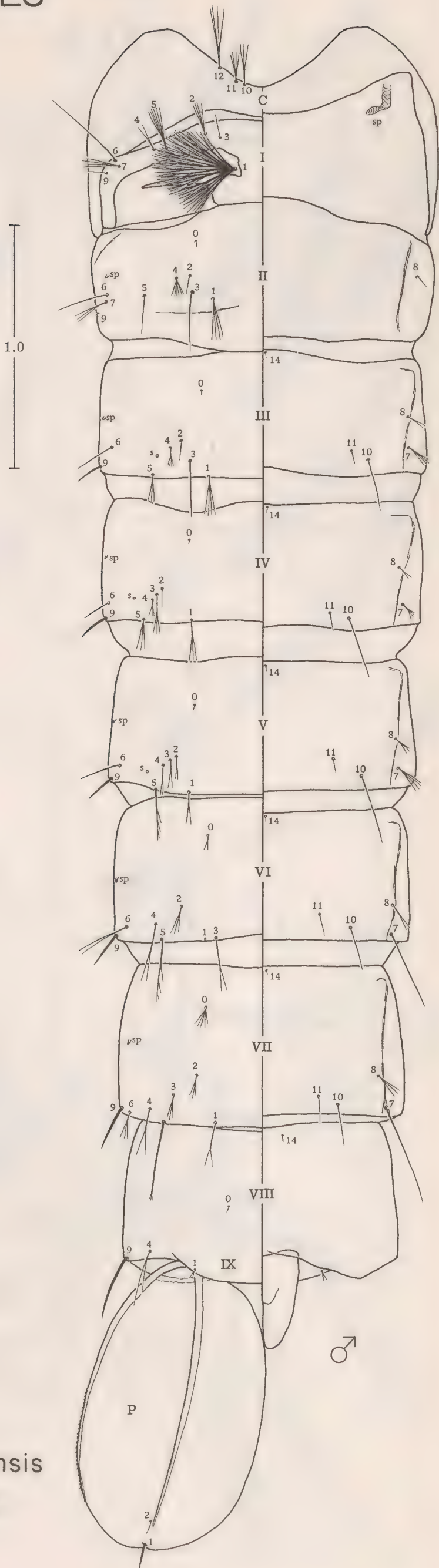
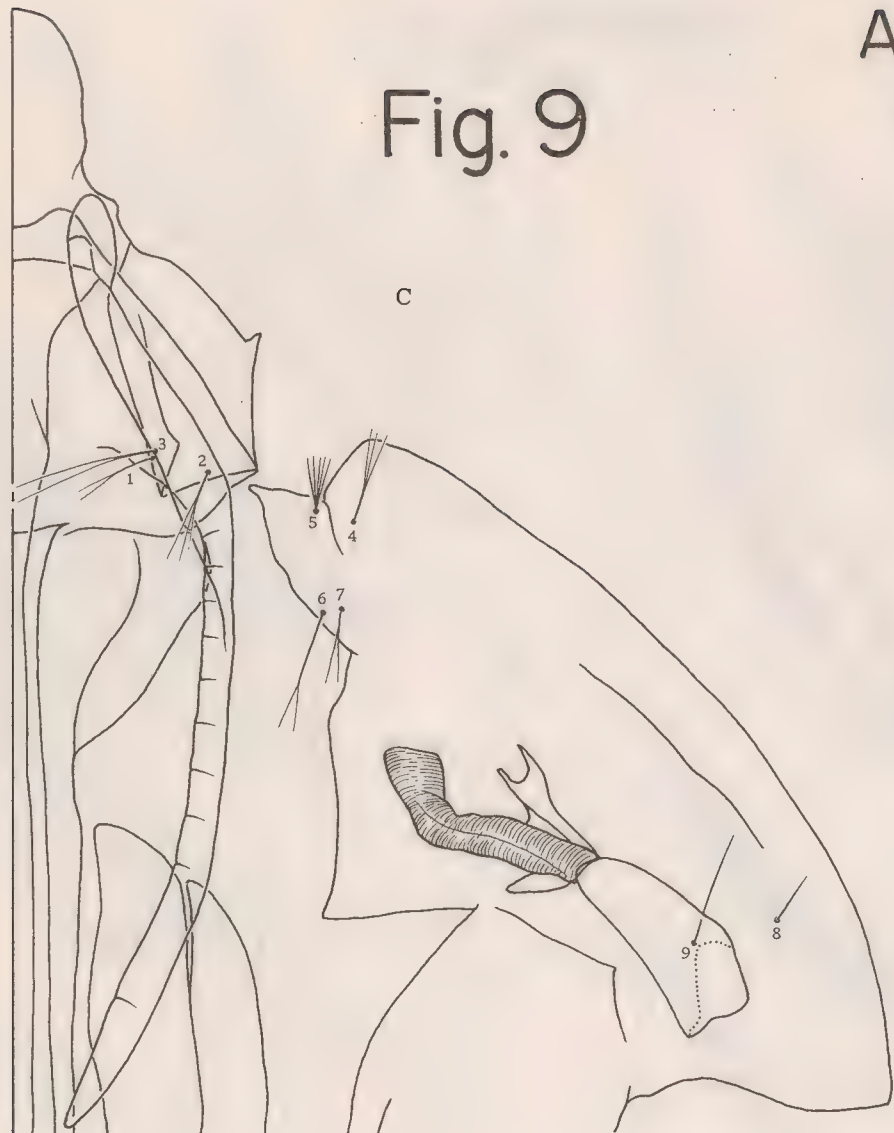


*arboricolus*

*Chiriqui  
Panama*

ANOPHELES

Fig. 9

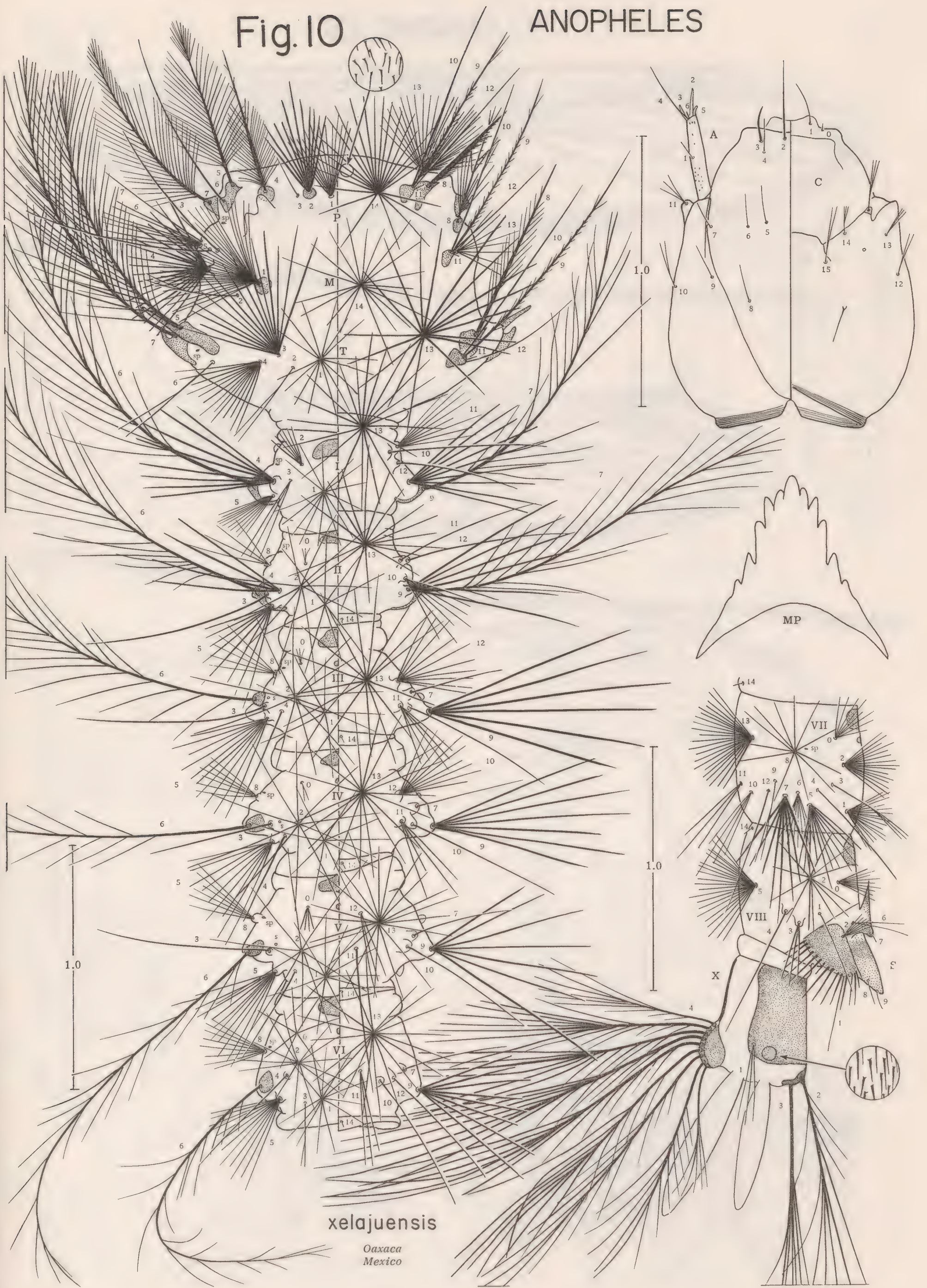


xelajuensis

Oaxaca  
Mexico

Fig. 10

ANOPHELES

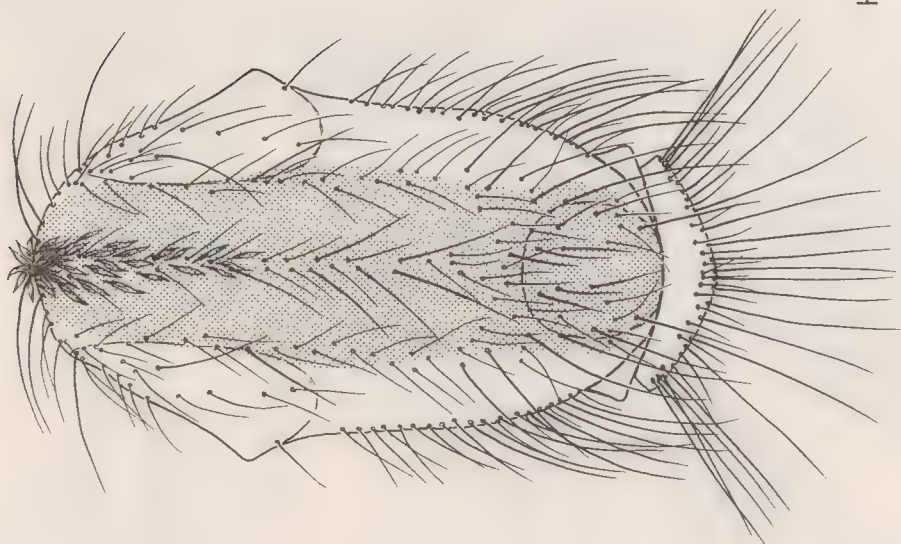
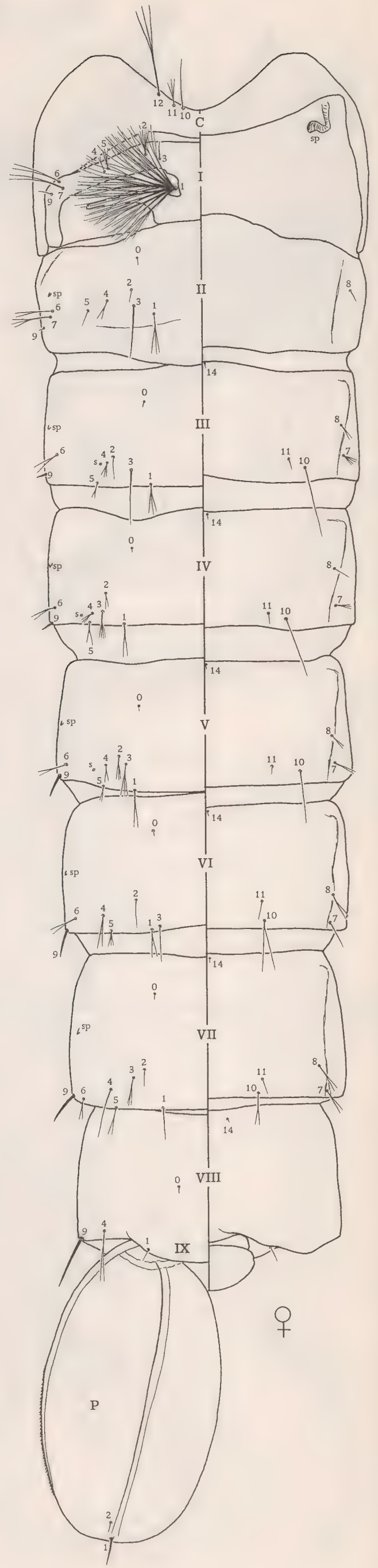
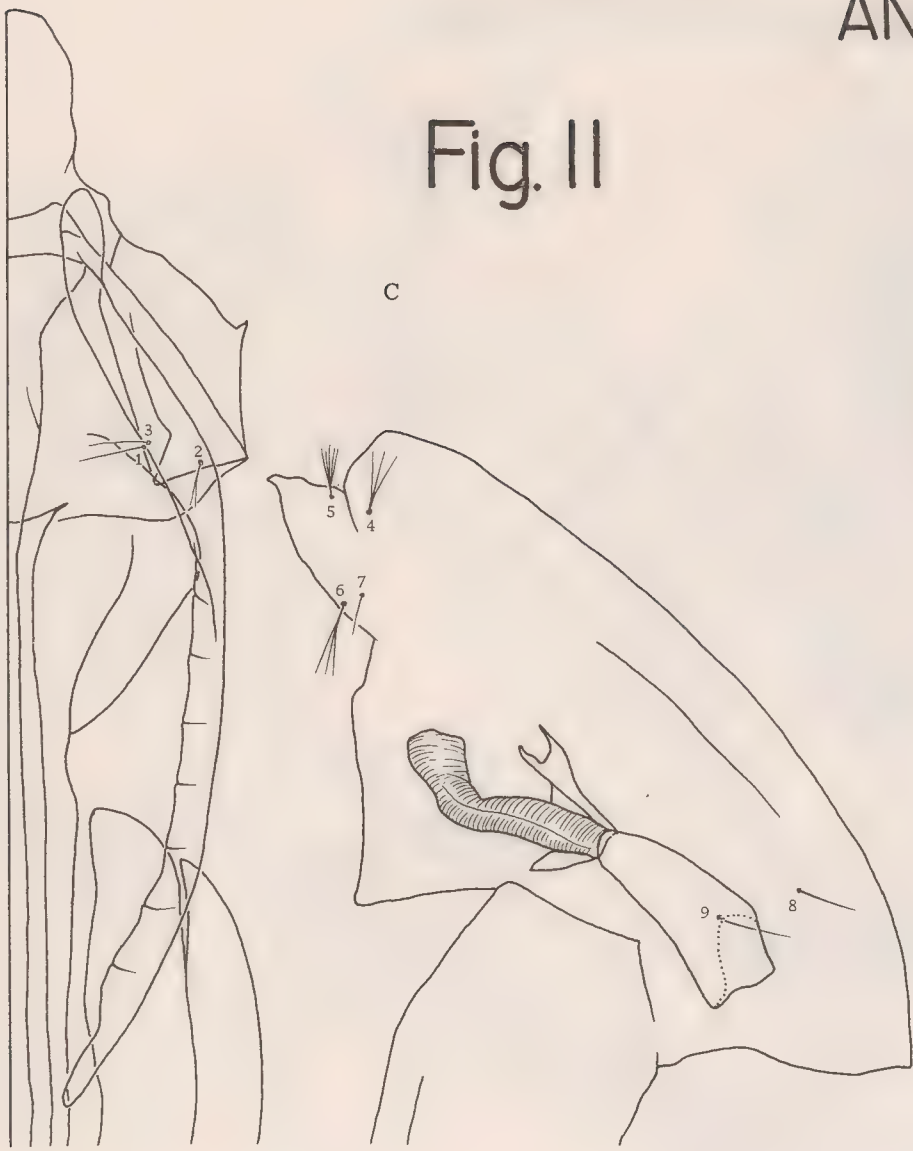


*xelajuensis*

Oaxaca  
Mexico

ANOPHELES

Fig. II



powderi

CR 50  
San Jose  
Costa Rica



Fig. 12

ANOPHELES

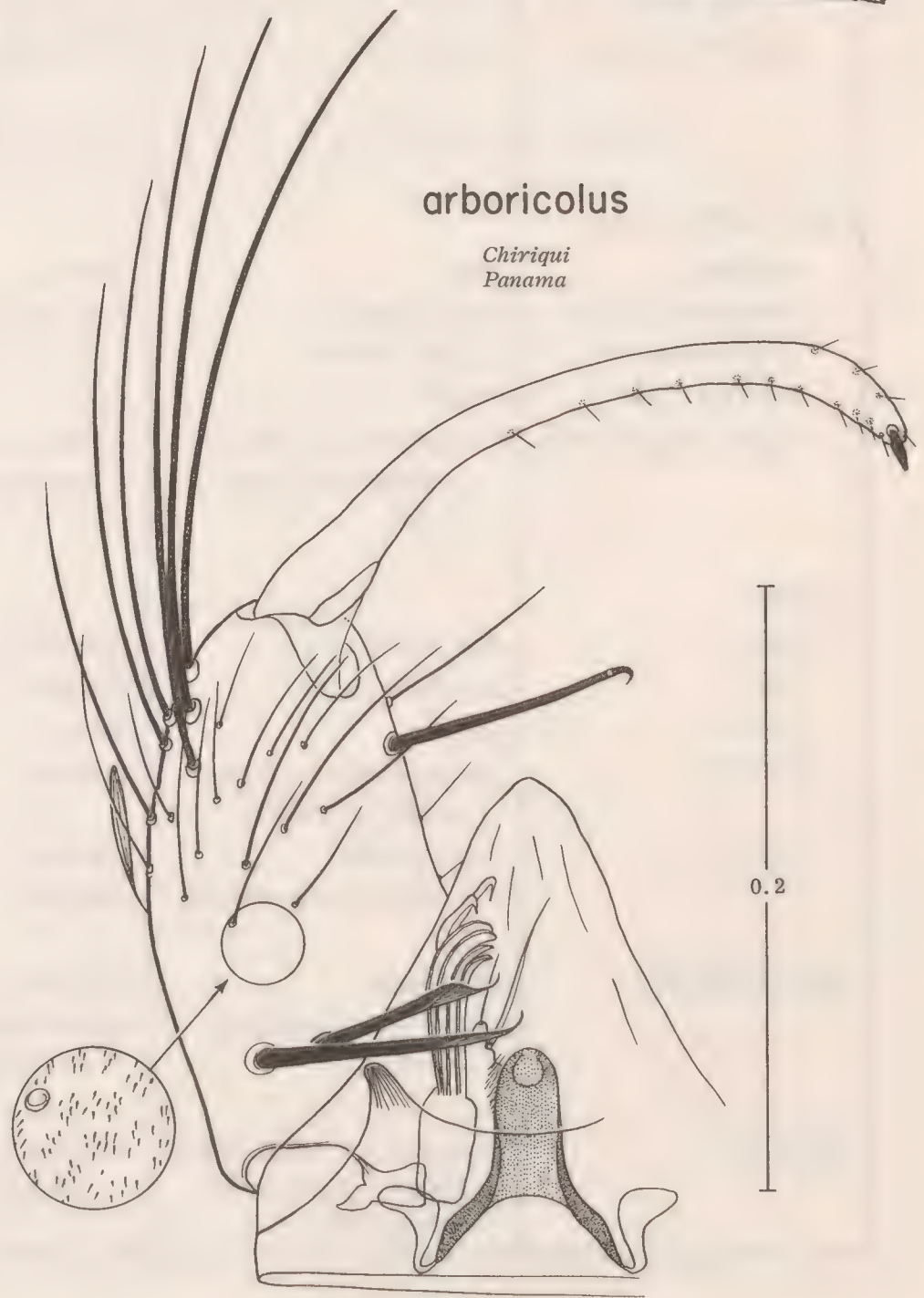
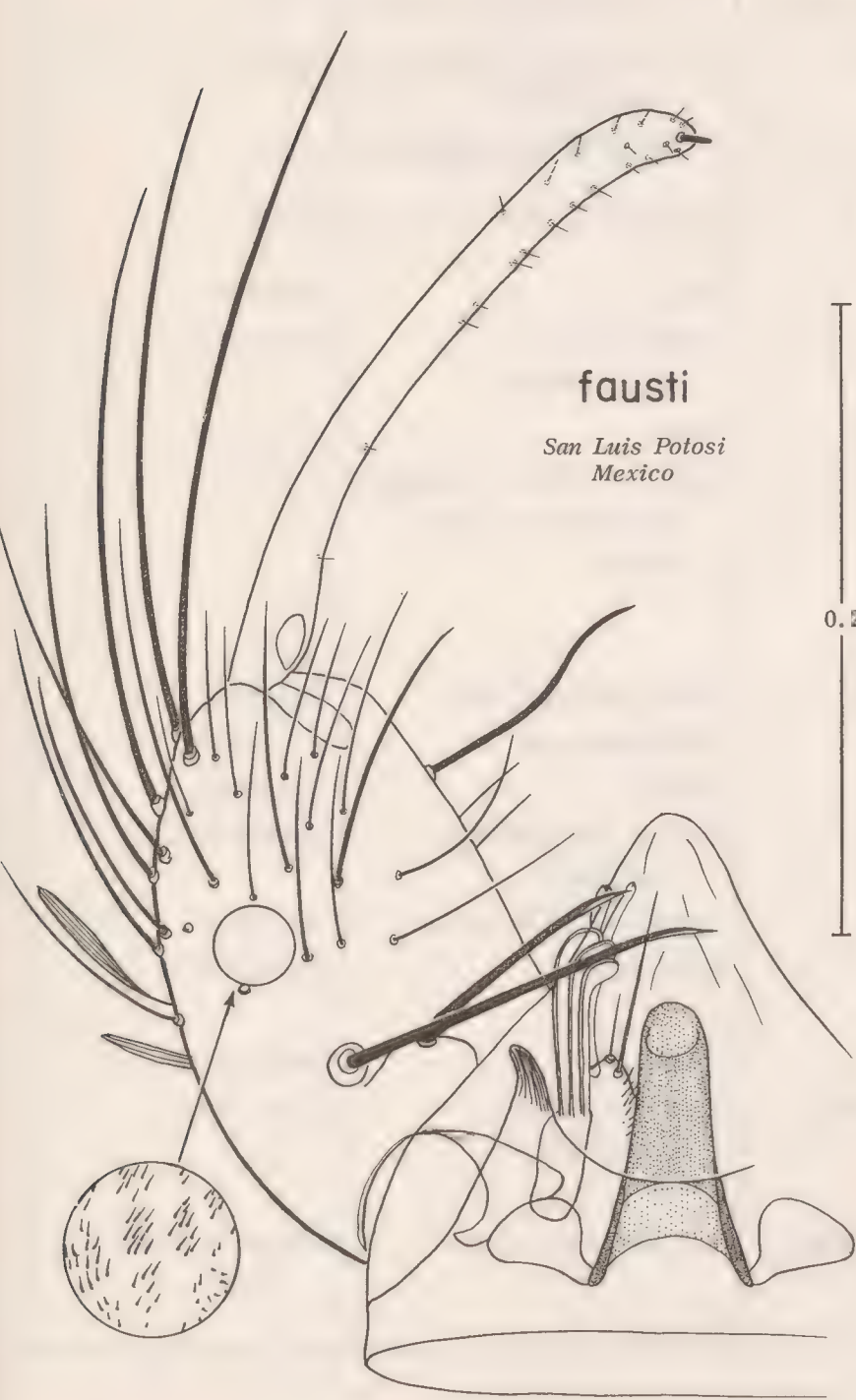
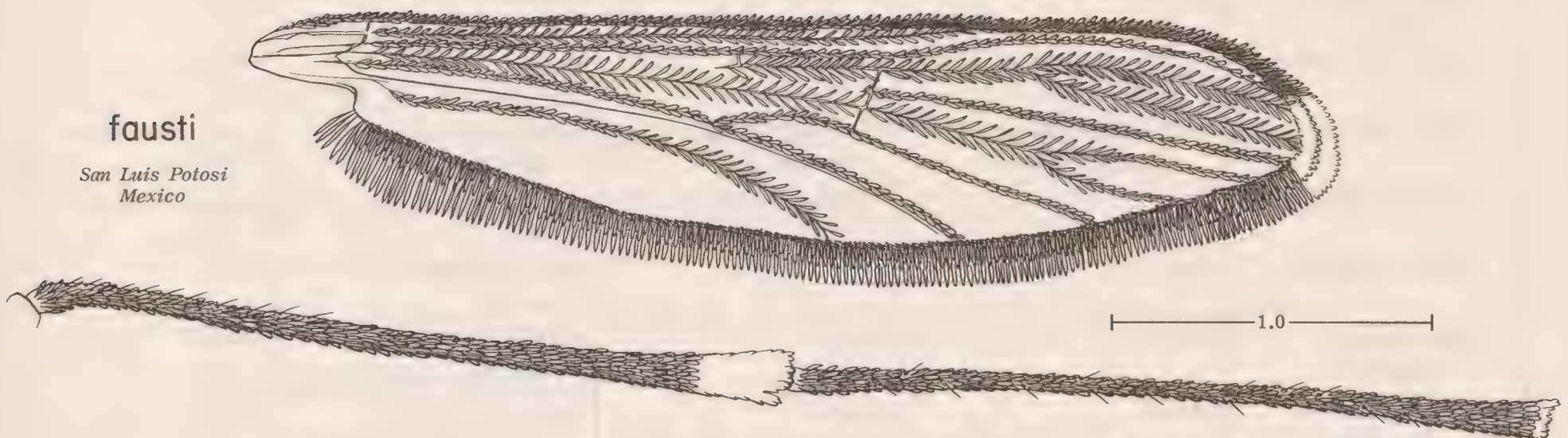


TABLE 1.  
Groups of New World treehole Anopheles

CHARACTER	<i>barberi</i> and <i>judithae</i>	<i>arboricolus</i> and <i>fausti</i>	<i>xelajuensis</i>	<i>powderi</i>
SIZE	small	small	large	large
ADULT				
interocular scales	absent to numerous and short	numerous and long	numerous and long	numerous and long
erect head scales	light mesally, light or darker laterally	bright white mesally, very dark laterally	bright white mesally, very dark laterally	bright white mesally, very dark laterally
light palpal patches mesonotum	absent	present	absent	absent
mesonotal hoary stripe	shortened and arched	longer and flatter	longer and flatter	longer and flatter
acrostichal scaling	absent	present	present	present
color of coxae	absent or tuft on promontory	long line	long line	long line
apex of hindfemur	same as adjacent portions of pleuron	much lighter than pleuron	much lighter than pleuron	much lighter than pleuron
apex of hindtibia	dark	conspicuous white ring	conspicuous white ring	conspicuous white ring
dark spots on wing veins	dark	dark	conspicuous white patch	dark
light patches on wing veins	absent	absent	present at base of branches	absent
light fringe spots	absent	absent	present at apex of costa and R <sub>1</sub>	absent
		1, from R <sub>1</sub> to R <sub>4+5</sub>	4, 1 from R <sub>1</sub> to R <sub>4+5</sub> , 1 each at end of M <sub>1+2</sub> , M <sub>3+4</sub> and Cu <sub>1</sub>	1, from R <sub>1</sub> to M <sub>1+2</sub>
MALE GENITALIA				
sidepiece	short	short	long	unknown
arrangement of side-piece spicules	singly, rows or small clumps	large clumps	singly, rows or small clumps	unknown
sidepiece scales	absent	few	many	unknown
ventral claspette lobe	lateral seta not as strongly developed as 1 next mesad	lateral 2 setae subequally developed	lateral seta not as strongly developed as 1 next mesad	unknown
LARVA				
hair 3-C	fine, mesad of 4-C	fine, laterad of 4-C	thick, laterad of 4-C	unknown
11-C	1-3b from base	plumose	2-5b from base	unknown
1-III-VII	palmate	palmate	stellate	unknown
9-III-VI	branched from base, moderately developed	plumose	stellate, very strongly developed	unknown
4-IV,V	simple, single	plumose	simple, single or double	unknown
10-VII	2,3b from base or middle	plumose	4-6b, stellate	unknown
DISTRIBUTION	widespread United States, northern Mexico	restricted central Mexico, western Panama	restricted southern Mexico, Guatemala	restricted Costa Rica
HABITAT	temperate deciduous forest, xeric evergreen forest, gallery forest	humid montane forest, tropical forest	wet montane forest	montane cloud forest

## INDEX TO SCIENTIFIC NAMES

- arboricolus** Zavortink, 2, 3, 5-7k, 14, 14-15, 17; 1, 8, 12  
**barberi** Coquillett, 1, 2, 3, 5-7k, 7-10, 10, 11, 13, 16; 1-4  
*barberi* of authors, 10  
**barianensis** James, 2  
*Coelodiazesis* Dyar & Knab, 2  
*Cyclophorus* Eysell, 2  
**eiseni** Coquillett, 3, 5-6k  
**fausti** Vargas, 1, 2, 3, 5-7k, 12-14, 14, 15; 1, 7, 12  
*fausti* of authors, 14, 15  
**judithae** Zavortink, 2, 5-7k, 8, 9, 10-12, 13, 16, 18; 1, 5, 6  
**plumbeus** Stephens, 2  
**powderi** Zavortink, 2, 3, 5-6k, 16, 17, 17-18; 1, 11  
*Russellia* Vargas, 2  
**xelajuensis** de Leon, 1, 2, 3, 4, 5-6k, 9, 15-17, 17, 18; 1, 9, 10, 12  
*xelajuensis* of authors, 13, 14, 15, 17, 18